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RESEARCH ARTICLE

Uses, ecology, and management of *Butia yatay* (Arecaceae) in Brazil: what do local communities tell us?

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Abstract The palm genus *Butia* comprises 22 species from Argentina, Brazil, Paraguay and Uruguay. Many of them produce edible fruits rich in antioxidant compounds, such as *Butia capitata, B. catarinensis, B. eriospatha, B. odorata* and *B. yatay*. They are regarded as underutilized and neglected species, besides being threatened with extinction in Brazil due to expansion of agricultural areas, intensive livestock farming and growth of cities. The objective of this study was to document the popular knowledge associated with the use, ecology, and management of *Butia yatay* in their occurrence area in Rio Grande do Sul State, southern Brazil. This ethnobotanical study characterizes the knowledge associated with genetic resources of *B. yatay* in Brazil, which aids in developing species conservation strategies. Seventeen people with ages ranging from 34 to 88 years were interviewed in two municipalities distant 330 km each other: eight in the municipality of Quaraí and nine in Giruá. They reported different forms of use involving all parts of the plant, mainly for food, beverage production, and handicrafts. However, the number of citations was very contrasting between the two regions: respondents from Quaraí cited 16 uses, while those from Giruá cited 79. It was observed that local communities have accumulated knowledge about the uses, ecology, and management of this palm over generations. However, part of this knowledge is being lost due to rural exodus, particularly in the municipality of Quaraí. There is a collective concern and interest in the conservation of *B. yatay*, and some suggestions for the conservation of the species were reported. Moreover, it is unanimous among participants that the species has nutritional, tourism, and income-generating potential. In this sense, there are movements aimed at strengthening the production chain in Giruá, while the residents of Quaraí mention the current lack of incentives. The knowledge of communities about the ecology and management of *B. yatay* highlights the admiration and respect that people have for these palms. Additionally, these plants are associated with emotional ties, with bonds formed since childhood.

Keywords Plant genetic resources · Sociobiodiversity · In situ conservation · Underutilized and neglected species

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Introduction

Palms are among the most important botanical families (Arecaceae) for humans (Lorenzi 2010). *Butia* (Becc.) Becc. consists of 22 species from South America, with occurrences in Argentina, Brazil, Paraguay, and Uruguay (Heiden and Sant'Anna-Santos 2025; Sant'Anna-Santos 2021; Soares 2015). The *Butia* palms have an economic and cultural relationship with society in their regions of occurrence. Their relevance is mainly linked to the use of their fruits and leaves, which are consumed fresh and used as ingredients in various food and beverage recipes, as well as to produce handicrafts (Barbieri et al. 2015; Dutra et al. 2021; Sosinski et al. 2019).

Although these palms produce fruits with economic, nutritional, and food value, they are still underutilized and neglected plants (Barbieri et al. 2022). They also face the threat of extinction in Brazil due to human activities, as expansion of agricultural areas, intensive livestock farming and growth of cities. In Rio Grande do Sul state, southern Brazil, all eight occurring *Butia* species are included in the list of endangered species (Rio Grande do Sul 2014). Thus, to support ecosystem conservation and mitigate the vulnerability of these species, it is necessary to increase our knowledge about their characteristics and their ecological features (Berté, 2013; Salgado et al. 2024). In this context, ethnobotanical research can be valuable allies in characterizing the knowledge associated with the genetic resources of the *Butia* genus.

Ethnobotany is a science that focuses on studying the interrelationship between people from living cultures and the plants in their environment, incorporating aspects of both botany and anthropology. Research in this field can serve a variety of purposes and have an interdisciplinary nature (Albuquerque et al. 2022; Reis et al. 2023). In this same context, an assessment of traditional community knowledge associated with genetic heritage is one of the guidelines of the Brazilian Policy for the Conservation and Sustainable Use of Genetic Resources for Food, Agriculture, and Livestock (Brazil 2024).

The sustainable use of plant genetic resources contributes to biodiversity conservation, community subsistence, and the strengthening of territorial identity (Martin 1995; Sosinski Jr. et al. 2022). Recent research on the ethnobotanical relationships of local communities with *Butia* palms has documented a wide range of uses for these plants, as well as collective interest in conserving these ecosystems (Buttow et al. 2009; Dabezies and Rivas 2020; Keller and Paz-Deble 2020; Kumagai and Hanazaki 2013; Silveira et al. 2022; Wagner 2020; Wagner 2024). However, it is still necessary to recover traditional knowledge about different *Butia* species that face extinction risks, such as *Butia yatay* (Mart.) Becc.

In Brazil, *B. yatay* occurs only in the Rio Grande do Sul state, with recorded occurrences in the western region, near the border with Uruguay and Argentina. (Severo et al. 2020). Therefore, considering the vulnerability of this species and the importance of valuing the knowledge of local communities regarding genetic resources, this study aimed to survey the knowledge associated with the use, ecology, and management of *B. yatay* in the municipalities of Giruá and Quaraí, in Rio Grande do Sul state, southern Brazil.

Methodology

The ethnobotanical survey was conducted through interviews in two municipalities of Rio Grande do Sul state, where *B. yatay* occurs naturally. In Giruá, the interviews were carried out during the 15th Butiá Fair, from March 8 to 10, 2024. In the municipality of Quaraí, interviews were conducted in January of 2024 with residents of the Salsal and Coatepe rural communities. The municipalities are located 330 km from one another.

The proposal for this study was submitted to the Ethics Committee of the Universidade Federal de Pelotas (UFPel) and approved under registration number 75940623.9.0000.5317. After approval, the first stage of the research involved contacting potential participants to present the objectives of the ethnobotanical survey and the Free and Informed Consent Form.

The selection criterion for participation in the survey was the relationship with *Butia yatay* palms, such as the use of parts of the plant or its presence in the landscape. The first participants were contacted through referrals mediated by partners of the *Rota dos Butiazais* project. The snowball technique was adopted to expand the research, in which interviewees refer people from their network to participate in the

study (Albuquerque et al. 2010; Mweshi and Sakyi 2020).

A semi-structured questionnaire was used to conduct interviews, where respondents answered a series of pre-established questions and additional ones that arose spontaneously during the conversation (Martin 1995). The questionnaire was divided into two parts: the first included open-ended questions, allowing interviewees to elaborate on the plant's origin, historical uses, ecology, and cultivation. The second part contained objective questions aimed at collecting quantitative data on the potential uses of *B. yatay* in the region.

All interviews were recorded in audio format with the participants' consent and fully transcribed with the help of the TurboScribe software. The transcribed interviews were added to Zotero, a reference management software that facilitates the comparison of information provided by different participants. To protect participant identities, descriptions and citations in this study were presented only with an identification number and age.

The uses of *Butia* palms reported by participants were categorized into food, beverage production, utilitarian purposes, handicrafts, and landscaping. Handicrafts were defined as decorative items and personal accessories. For each category, the Use Diversity Index (UDI) was calculated using the formula: UDI = Σcat/Σall, where "cat" is the sum of mentions within a category, and "all" is the total sum of all mentions.

Results and discussion

The ethnobotanical survey resulted in 17 interviews, with 8 conducted in the municipality of Quaraí and 9 in Giruá. Some interviews were conducted with couples; however, as there was no consensus in their responses, they were analyzed separately. Regarding the participants' gender, 11 were women and 6 were men. The participants engage in various professional activities. In terms of age, they range from 34 to 88 years old. Among them, 5 reside in urban areas, while 12 live in rural areas. The complete list and description of the participants can be found in Table 1.

History and context of the interviewees from Quaraí

The interviews in the municipality of Quaraí were conducted with residents of the Salsal and Coatepe communities, a rural area where the largest palm grove remnant of *B. yatay* in Brazil is located (Marchiori and Alves 2011). Cattle farming is a common practice in this region and is

Table 1 Description of participants in the ethnobotanical survey

ID[1]	Age	Education level	Gen[2]	Occupation	Municipality	Area
1	58	Elementary school incomplete	M	Farmer	Quaraí	Rural
2	53	Elementary school incomplete	F	Homemaker	Quaraí	Rural
3	59	Elementary school incomplete	M	Farmer	Quaraí	Rural
4	88	Elementary school incomplete	F	Farmer[3]	Quaraí	Rural
5	77	Elementary school incomplete	M	Farmer[3]	Quaraí	Rural
6	59	Elementary school	F	Homemaker	Quaraí	Rural
7	88	Elementary school incomplete	M	Farmer[3]	Quaraí	Rural
8	54	Undergraduate	M	Farmer	Quaraí	Rural
9	64	Undergraduate	F	Artisan	Giruá	Urban
10	57	Elementary school incomplete	F	Farmer	Giruá	Rural
11	49	Graduate	M	Teacher	Giruá	Urban
12	45	High school	F	Farmer	Giruá	Rural
13	51	Elementary school incomplete	F	Farmer	Giruá	Rural
14	62	Elementary school	F	Artisan	Giruá	Urban
15	34	Graduate	F	Fashion designer	Giruá	Urban
16	54	Undergraduate	F	Social worker	Giruá	Rural
17	56	Graduate	F	Teacher	Giruá	Urban

[1]Identification; [2]Gender: *F* female, *M* male; [3]Retired

conducted in association with the *Butia* palm grove (Fig. 1), which marks a regional characteristic of the presence of cattle, horses and sheep in the landscape (Severo et al. 2020).

One of the participants was born and raised in Uruguay and moved to Quaraí a decade ago. She stated that it was at that moment she first noticed the ecosystem, since there were no Butia palm groves in the region she came from. The other seven participants were born and raised in Quaraí, accumulating traditional knowledge associated with the ecosystem over generations.

During the interviews, it was common to hear about the uses of *Butia* mature palm leaves from decades ago. In this regard, Participant 5 (77 years old) reported that using these leaves to feed cattle was common, especially in harsh winters when pasture was scarce. Participant 7 (88 years old) mentioned using the leaves as roofing for a shed attached to his family's house.

Another report about the uses of the leaves came from the older participants, who recalled a neighbor who wove the palm fronds to sell in the central area of Quaraí, where mattresses were made. Bairros (2011), evaluating the same communities, also recorded reports of this activity, which lasted for more than 30 years and was a source of income for the locality until the 1970s, when new technologies emerged for making mattresses and upholstery. Additionally, Participant 7 (88 years old) also mentioned that during that time, he used to sleep on a *Butia* palm fiberized leaves mattress, which had two sides: one with fiberized leaves for the summer and another with wool for the winter.

Regarding the fruits, the interviewees commonly stated that they are now rarely consumed because they don't like the taste. However, Participant 1 (58 years old) and Participant 2 (53 years old) mentioned that, during their childhood, it was common to go to the palm grove to eat *butiás*, as *Butia* fruits are called,

Fig. 1 Cattle farming as a prominent activity in the *Butia yatay* remnant ecosystem in Quaraí, Rio Grande do Sul state, Brazil

and they knew which palm trees produced the sweetest fruits. Over the years, this traditional knowledge has been lost, and 62.5% of the interviewees believe that rural exodus and population aging were responsible for this loss. Furthermore, according to Bairros' (2011) ethnobotanical survey, it was common to use the fruits to feed sheep, and the nuts were used to flavor *mate*, a typical hot drink from southern Brazil made of the leaves of *Ilex paraguariensis* A.St.-Hil.

The participants reported that nowadays these fruits are rarely utilized, but in the past, they were an essential food source, as described by the oldest interviewee:

> "*At first, the fruit was a great food. Back in the time of poverty, real poverty, you'd see people going under a butiá tree to eat the fruit. My father-in-law, who lived here a hundred years ago, right? Or even more... He used to say that in the time of poverty, they'd go at noon to sit under a butiá tree to eat the fruit. They would pick it, peel it there. And that was their lunch. It was a great food, it's food*" (Participant 7, 88 years old).

This report highlights that, in times of difficulty, the *Butia* palm grove of Coatepe and Salsal played an essential role in contributing to community's food security in the early twentieth century.

According to some interviewees, in the 2000s, there were courses offered in handicrafts and cooking, encouraging the use of *Butia* palms resources. During this period, community members used *Butia* palm dried leaves as roofing to construct a shed where community celebrations were held. Thus, the trade of liquors, jellies, and hats made from *Butia* palm dried leaves became common in the community. Currently, in the town center of Quaraí, a weekly producer's market is held where products derived from *butiás*, such as jellies, can be found.

The residents of the Coatepe and Salsal communities created the 'Associação dos Produtores Familiares do Butiazal' (Association of Family Producers of the *Butia* palm grove) to strengthen production through partnerships. Additionally, they promote cultural and recreational events such as championships of *truco* (a popular trick-taking card game played in South America, especially in Brazil and Argentina), barbecues, and horseback riding (Fig. 2). The association also aims to encourage tourism in the *Butia* palm grove, as they have noticed an increasing interest in recent years, welcoming tourists from other states from Brazil and from Italy.

History and context of interviewees from Giruá

The northwest region of Rio Grande do Sul state, where the municipality of Giruá is located, has undergone intense agricultural pressure in recent decades, altering natural ecosystems. The removal of native vegetation to make way for monocultures threatens the persistence of *B. yatay* in its natural habitat. Consequently, these palm trees have now remained only in pastures, field edges, and along roads and railways (Severo et al. 2020).

According to Participant 17 (56 years old), the municipality has a remnant population of *Butia yatay* palms, commonly known as '*Vale dos Butiazais*' (*Butia* palm grove valley). This remnant is located on private property where the interviewee grew up. She reports that, about five decades ago, her father's family sold *Butia* palm leaves to mattress and upholstery factories. The first *butiá* pulp-extracting machine in the region was also installed there. Additionally, the interviewee explained that, under her family's influence, she developed a bond with the *Butia* palms from an early age. Today, she is a teacher and mentions that, in the early 2000s, she assigned her students a project to document everything related to *butiás* in music, poetry, cuisine, and handicrafts. The students organized an exhibition that caught local politicians' attention regarding this palm's potential, initiating the first efforts to establish the '*Festa do Butiá*' (Butiá Festival).

The first Butiá Festival took place in February 2003, creating a marketplace for the fruit and its derivative products. With the introduction of culinary competitions and exhibitions, most interviewees stated that the creation of this event was a turning point in their professional careers. At this moment, they began to explore the potential of the fruit and leaves, developing various recipes and handicrafts. Over time, the festival grew in scale, became a municipality symbol and was officially renamed to '*Feira do Butiá'* (Butiá Fair) in 2007.

Interviewees report that it is common to find people selling *butiás* along highways. However, before the Butiá Fair began, this type of roadside trade was even more widespread, as it was the only sales

Fig. 2 Cap of the Association of Family Producers of the *Butia* palm grove (**a**); Trophy from cultural event promoted in the *Butia* palm grove of Coatepe (**b**)

channel available. The development of new opportunities through this event has allowed *B. yatay* to become even more integrated into the local cultural context, as illustrated in Fig. 3.

Additionally, participant 11 (49 years old) reveals that the '*Cadeia Solidária das Frutas Nativas do Rio Grande do Sul'* (Solidarity Chain of Native Fruits of Rio Grande do Sul), a non-governmental organization, helped break the paradigm among local farmers regarding the inability to manage *Butia* palms. Through this initiative, knowledge about the sustainable management of native fruits is being disseminated, directly contributing to the development of the *butiá* production chain.

Currently, every Tuesday and Friday, the '*Feira de Produtos Coloniais'* (Colonial Products Fair) takes place in the municipal square, where vendors sell *butiá* pulp, derivative products, and bunches of fruit (during harvest season). Additionally, an association of 21 culinary professionals and artisans called '*EcoButiá'* has physical infrastructure and equipment for pulping and storing the fruit. This association supplies products to ice cream shops, restaurants, and snack bars in the region, as well as to the Giruá city hall, which redistributes them to schools for use in school meals.

Uses of *Butia yatay*

In the municipality of Quaraí, interviewees mentioned 16 different ways of using *Butia* palms, covering the fruits, leaves, almonds, and the entire plant. According to Table 2, the highest Use Diversity Index (UDI) values were observed in the categories of "food" and "utilities," with UDIs of 0.34 and 0.32, respectively. The categories of "beverages," "handicrafts," and "landscaping" had UDIs below 0.20. In Fig. 4, the most frequently mentioned uses include the production of liqueur, cattle feed, *quinchado* roof construction (a covering made of *Butia* dry leaves to

Fig. 3 The *butiás* as a cultural element in the municipality of Giruá, Rio Grande do Sul state, Brazil

Table 2 Uses of *Butia yatay* in Quaraí, Rio Grande do Sul state, Brazil

Category	Food	Beverages	Utilities	Handicraft	Landscaping
Mentions of use	Almond (raw) (n = 4) Fruit (raw) (n = 4) Sweets (n = 3) Ice cream (n = 2) [1]Jam(n = 1) [1]Jelly (n = 1) Sweet in syrup (n = 1)	[2]Liqueur (n = 6) Juice (n = 2) [2]Flavored *cachaça* (n = 1)	*Quinchado* roof (n = 6) Animal feed (n = 5) Mattress (n = 4)	Hat (n = 4) General handicrafts (n = 2)	Plant as an element of landscaping (n = 1)
UDI	0.34	0.19	0.32	0.13	0.02

"n" refers to the number of mentions. UDI: Use Diversity Index. [1]Although they are synonyms in some regions, the participants reported differences in the preparation methods; [2]For flavored *cachaça*, the fruit is left to soak for a period, whereas the preparation of liqueur requires boiling the pulp

Fig. 4 Word cloud of usage citations in the municipality of Quaraí, Rio Grande do Sul state, Brazil

rustic roofs or shelters), and the consumption of fruits and almonds in their natural state.

The participants from the municipality of Giruá mentioned 79 different uses involving all parts of the *Butia* palm except the roots. According to Table 3, the highest UDI is observed in the "food" category, with 0.54. The "beverages" and "utilities" categories stood out, with UDI values of 0.22 and 0.15, respectively. The "handicrafts" and "landscaping" categories had a UDI lower than 0.10. The most frequently mentioned uses are shown in Fig. 5.

Among the two municipalities, the categories with the highest Use Diversity Index (UDI) were "food," "beverages," and "utilities." In an ethnobotanical survey for *Butia eriospatha* (Mart. ex Drude) Becc., Wagner (2024) reported as the most frequently mentioned uses food (UDI of 0.56) and beverage production (UDI of 0.20), similar to the list of uses in the municipality of Giruá. Ethnobotanical research on other *Butia* species and in other places has shown that food and beverage production are the interviewees' most reported uses (Buttow et al. 2009; Kumagai and Hanazaki 2013; Silveira et al. 2022).

According to Leonti (2022), comparing ethnobotanical indices between different communities can be problematic due to sample sizes and the cultural specificities of each region. From this perspective, it is evident that each municipality's cultural and economic context led to a contrast in the number of reported uses, which directly influenced the use of diversity indices. In Quaraí, interviewees listed 47 mentions for 16 different uses, while in Giruá, 171 mentions were recorded for 79 different uses.

Among the parts of the plant the most used is the fruit, which is included in many food recipes and beverage production. The almonds are also used as ingredients in sweet recipes and in the production of liqueurs. The endocarps are used in a handcrafted manner, serving as details in botanical jewelry art and decorative items. The leaves are used in the production of handicrafts (accessories and decorations) and utilitarian items, with the technique employed in their making being regional, highlighting the cultural identity of each municipality (Fig. 6).

Additionally, among the interviewees in Quaraí, the most frequently mentioned uses for the leaves were animal feed and the production of *quinchado* roofs, although they acknowledge that these practices have now fallen into disuse. In Fig. 7, it is possible to observe the proportion of each category among the different mentions in both municipalities and for the different parts of the plant is observed.

All interviewees from Giruá mentioned the consumption of fresh fruits, in contrast to the group from Quaraí, where only 50% reported this use. By examining other ethnobotanical surveys on *Butia*, the same variation in the consumption of fresh fruit can be observed. Silveira et al. (2022), interviewing people from different regions of Brazil, Argentina, and Uruguay, noted that all interviewees mentioned the consumption of fresh fruit. Similarly, Wagner (2024) observed that for *B. eriospatha*, the consumption of fresh fruit is unanimous. However, Kumagai and Hanazaki (2013) reported that only 47% of respondents stated they consumed fresh fruits of *Butia catarinensis* Noblick & Lorenzi in Imbituba, coast of Santa Catarina state, southern Brazil.

Although fresh fruit consumption varies regionally, the use of different parts of the plant in sweet and savory recipes, juices, *cachaça*, handicrafts, utilities, and landscaping is reported in various locations where the *Butia* genus occurs (Buttowet al. 2009; Dabezies and Rivas 2020; Keller and Paz-Deble 2020; Kumagai and Hanazaki 2013; Silveira et al. 2022; Wagner 2020; Wagner 2024).

Due to its versatility and nutritional food potential, *Butia* palms have been used for more than 9,500 years by South American native people, as evidenced by some archaeological records (López Mazz 2001; Rivas et al. 2023). These people also developed a tool to extract the almonds from the endocarps, called "*quebra-coquinho*" (nutcracker), and it is believed that they contributed to the domestication of *Butia* species. Additionally, some ethnobotanical surveys with Guarani people in the Misiones region

Table 3 Uses of *Butia yatay* in Giruá, Rio Grande do Sul state, Brazil

Category	Food	Beverages	Utilities	Handicraft	Landscaping
Mentions of use	Fruit (raw) (n = 9) Sweets (n = 8) Jam (n = 7) Sweet in syrup (n = 7) [1]*Cuca* (n = 5) Almond (raw) (n = 4) Ice cream (n = 4) Mousse (n = 4) Pie (n = 4) Sauce (n = 4) Cake (n = 3) [2]*Rapadura* (n = 3) Biscuit (n = 2) Cream (n = 2) Flavored mustard (n = 2) Pastry (n = 2) Pizza (n = 2) Bonbon (n = 1) Butter (n = 1) Cheesecake (n = 1) Chocolate truffle (n = 1) [3]*Cocada* (n = 1) Cookie (n = 1) *Cornetto* (n = 1) *Crepe* (n = 1) Crunchy (n = 1) Dehydrated fruit (n = 1) [4]*Farofa* (n = 1) Lasagna (n = 1) Paella (n = 1) *Peanut brittle* (almond) (n = 1) *Peanut brittle* (n = 1) Popsicle (n = 1) Pudding (n = 1) Sago pudding (n = 1) Snacks (n = 1) Sweet (almond) (n = 1)	[5]Liqueur (n = 9) Juice (n = 6) [5]Flavored c*achaça* (n = 5) Lager beer (n = 3) Almond liqueur (n = 2) Beer (n = 2) Flavored vodka (n = 2) Kombucha (n = 2) Tea (n = 2) Wine (n = 2) *Caipirinha* (n = 1) Milkshake (n = 1)	Endocarp as substrate (n = 2) Placemats (n = 2) Pots (stems) (n = 2) Adornment (n = 1) Animal feed (n = 1) Basket (n = 1) Bed headboard (n = 1) Bottle decoration (n = 1) Carpet (n = 1) Curtain (n = 1) Cushion (n = 1) Endocarps for games (n = 1) Folding screen (n = 1) Garnish (n = 1) Hat (n = 1) Lamp (n = 1) Mattress (n = 1) Shade net (n = 1) Sideboard (stem) (n = 1) Soap (n = 1) Thermos bottle cover (n = 1) Vegetable packaging (n = 1) Wallet (n = 1)	Bags (n = 3) Earrings (n = 2) Necklace (n = 2) Decorative arrangement (spathe) (n = 1) Tiara (n = 1)	Plant as an element of landscaping (n = 6) Cultivate orchids on the stem (n = 1)
UDI	0.54	0.22	0.15	0.05	0.04

"n" refers to the number of mentions. UDI: Use Diversity Index. [1]Cuca is a Brazilian cake with a crumbly topping, often made with fruit or cream; [2]Rapadura is a traditional Brazilian sweet made from sugarcane juice, cooked and solidified into blocks; [3]Cocada is a traditional Brazilian coconut sweet made with grated coconut and sugar or condensed milk; [4]Farofa is a traditional Brazilian side dish made from toasted cassava flour, often mixed with butter, bacon, and other seasonings; [5]For *cachaça*, the fruit is left to soak for a period, whereas the preparation of liqueur requires boiling the pulp

Fig. 5 Word cloud of usage citations in the municipality of Giruá, Rio Grande do Sul state, Brazil

Fig. 6 Handicrafts made with *Butia yatay* leaves in the municipality of Giruá (**a**, **b**, **c** and **d**) and in Quaraí, Rio Grande do Sul state, Brazil (**e**)

(Argentina) indicate that the leaves were used for building shelters and making toys for children (Dutra et al. 2021; Keller 2008; Keller 2011).

Emotional ties with *Butia* palm

A recurring memory among interviewees was cracking nuts to eat the almonds, an activity they recalled from childhood but abandoned in adulthood.

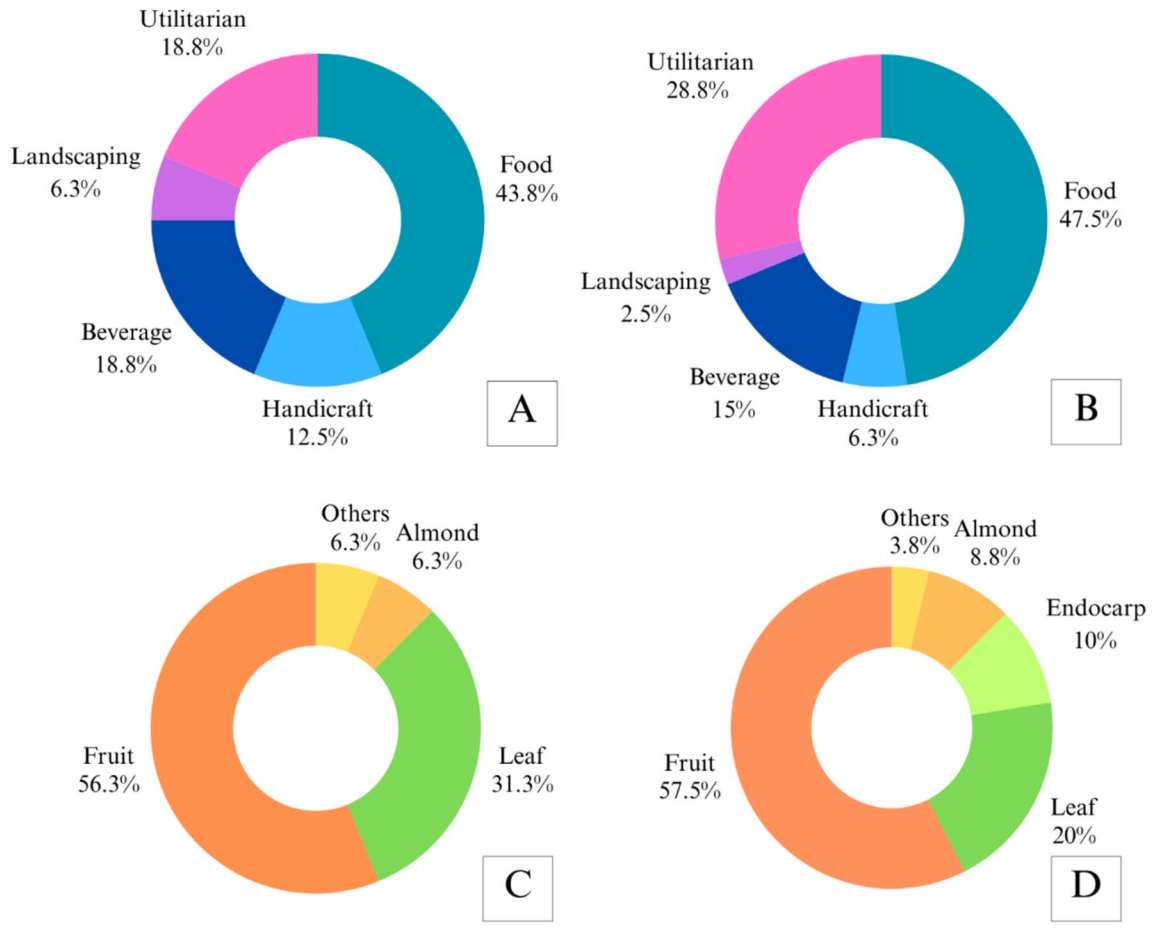

Fig. 7 Distribution of total citations by usage category in the municipalities of Quaraí and Giruá, Rio Grande do Sul state, Brazil, respectively (**A** and **B**); Distribution of usage citations by plant parts in the municipalities of Quaraí and Giruá, respectively (**C** and **D**)

According to Ramos et al. (2024), with globalization, communities have distanced themselves from past habits regarding the use of biodiversity. In an ethnobotanical survey conducted in the highlands of Santa Catarina and Rio Grande do Sul states, Wagner (2024) reported a similar situation for *B. eriospatha*, considering that the abandonment of these practices reflects the immediacy experienced by modern society.

Associated with childhood memories of *butiá* nuts, one interviewee recalled a childhood game called "*jogo das cinco marias*" (game of five stones). This game is typically played with small bags filled with sand or rice, which are tossed into the air while collecting others from the ground before the airborne one falls (Maldonado et al. 2021). For this interviewee (49 years old), the material used for the game was endocarps of the fruits, demonstrating how *B. yatay* is embedded in his childhood memories.

Another interviewee mentioned that in Giruá, it is common for families to have homemade liqueurs to gift loved ones and serve guests. Likewise, the memory of grandmothers was highlighted by several interviewees, recalling teachings on leaf weaving and the experience of tasting *butiá* sweets and fruits for the first time. Participant 15 (34 years old) stated, "My grandma made the best *butiá* sweet on the face of the Earth." Meanwhile, participant 10 (57 years old) revealed that she used to get scolded by her grandmother for overeating: "My grandma worried that I would swallow the seed."

In Giruá, the development of the *Butiá* Fair recognized individuals who excelled in contests such as the best cake and best *butiá*-based recipe. One interviewee explained that she took *Butia* palm leaf handicrafts to the Lusophone Festival in 2011 in Macau, China, which aimed to unite Portuguese-speaking countries for an exhibition of handicrafts and traditional dishes.

Among the Quaraí interviewees, there was unanimity in valuing the *Butia* palm. They all have a strong connection with the ecosystem and a sense of belonging to the region. In the words of Participant 6 (59 years old): "[…] for me, this is a relic […], we must take care of it and protect the environment so it continues." Participant 7 (88 years old) commented: "I don't think this should disappear. We need to preserve it. It grew here naturally. We didn't plant it." Participant 8 (54 years old) highlighted their daily connection with *Butia* palms: "I wake up in the morning and see the *butiás*, I drink my coffee looking at them." These statements demonstrate the community's deep sense of belonging and respect for the *Butia* palm grove.

Many interviewees expressed gratitude toward the *Butia* palm, including one participant who currently produces handicrafts with leaves and various beverages from fruits and almonds. This interviewee developed a deep emotional bond, as she now sees her work as a way to recover from past losses. She shared:

> "*I am passionate about butiá. It even makes me emotional. My father was murdered when I was 10 months old by a hired assassin. My father had bought land in Paraná state, and they ordered his killing. The killer ambushed him behind a butiazeiro (Butia palm). This is something I only recently discovered, as I was too young to know the story. [...] The butiazeiro is a turning point in my life. Today, I am gaining recognition. I am earning a lot of money. [...] It was very difficult… and then the butiazeiro gave me my life back, it gave me wealth again*" (Participant 9, 64 years old).

Some others mentioned emotional ties that included the *Butia* palm as a source of resilience during hard times, such as using the fruits for food security. Participant 10 (57 years old) recalled using the leaves as roofing material for her home's entrance to reduce the relentless summer heat.

Variability and conservation of *Butia yatay* genetic resources

According to Kubo et al. (2006), environmental conservation should be linked to local development based on the autonomy and empowerment of local communities. In this context, participants were asked about their perception of the ideal fruit for consumption and product manufacturing. The most desirable fruits for them are the large ones with small endocarp, and sweet and less acidic pulp. However, some participants emphasized that there is no ideal fruit, and that each producer seeks the one they prefer to work with, making variability an essential element to cater to all preferences. In the words of Participant 11 (49 years old): "*Butiá*, in essence, is diversity."

The *Butia* genus exhibits vast genetic variability, noticeable within a single species. This occurs because these palm trees are allogamous, meaning they primarily reproduce through cross-pollination, where pollen from one plant fertilizes the stigma of another (Severo et al. 2020; Soares 2013). Participants reported observing variability in several morphological characteristics. Participant 15 (34 years old), a fashion designer who collects *Butia* palm leaves to handicraft her products, mentioned that after the scraping process, a range of leaf color shades can be observed, including orange, gray, white, green, and red.

Regarding the fruits, interviewees noted variability in color, size, pulp-to-endocarp ratio, pulp flavor, and almond flavor. The reported fruit colors included yellow, red, orange, and green. Size is a quantitative variable, and respondents mentioned knowing small, medium, and large fruits. In terms of flavor, interviewees from Giruá highlighted variations in acidity and sweetness, while those from Quaraí classified them as either "bitter" (referring to acidity) or sweet. One interviewee (Participant 10, 57 years old) reported noticing variability in the taste of the almonds, categorizing them as bitter, sweet, or neutral.

In alignment with the knowledge gathered from these communities, Mistura (2013) analyzed the genetic structure of a natural population of *Butia odorata* (Barb. Rodr.) Noblick and observed that

individuals differ in growth habits, leaf color, rachillae and flower colors, number of fruit clusters, as well as fruit color, shape, size, weight, flavor, and fiber content.

Despite the diversity observed by local communities, agricultural and urban pressures have reduced the genetic variability of populations, threatening biodiversity resilience (Berté, 2013; Sosinski Jr. et al., 2019). Currently, the conservation status of *Butia* palms is concerning. As pointed out by Eslabão et al. (2022), *B. yatay* is classified as vulnerable according to the criteria of the International Union for Conservation of Nature (IUCN). The species is officially listed as "Vulnerable" in the List of Brazilian Flora Species Threatened with Extinction and as "Endangered" in the List of Native Flora Threatened with Extinction in the State of Rio Grande do Sul (Brazil 2022; Rio Grande do Sul 2014). In this context, interviewees were asked about their perception of threats to the *Butia* palm.

Among the respondents, 52.9% agreed that the species is at risk of extinction, while 47.1% disagreed. However, 94.1% believed that the degradation of *Butia* palm grove could negatively impact the quality of life, and 88.2% believed that individual actions could contribute to the conservation of *Butia* palms. When asked for examples of actions that could be taken, distinctions were observed between participants from different municipalities. While the residents of Quaraí considered proper cattle management a fundamental issue, those from Giruá emphasized the importance of preserving the remaining individuals. Other suggested actions included using the plant in landscaping, promoting its potential and benefits, and reporting environmental violations to authorities.

Potentialities and needs for consolidating the production chain

When asked about the main benefits that *Butia* palm groves can provide, 100% of the interviewees agreed that these ecosystems conserve *Butia* species, serve as a food source for both people and animals, provide income opportunities, and function as recreational areas. Additionally, 76.5% of participants believe that *Butia* palm groves have the potential for natural medicine. Other cited potentials included serving as a natural habitat for wildlife and the production of soap using fruit pulp.

In Brazil, many native plant species threatened with extinction are neglected despite their potential to generate income for small producers (Severo et al. 2020). It is well discussed that *Butia* palm trees have income-generating potential through the use of their fruits and leaves (Ambrosini et al. 2021). In this context, all participants in this ethnobotanical survey agreed that *B. yatay* has commercial potential. Participant 13 (51 years old) mentioned that the market is growing and stated that she supplies approximately 4,000 kg of pulp per year to a buyer in Santa Catarina state, who uses it to produce beverages. Furthermore, 100% of the interviewees believe that *Butia* palm groves have tourism potential, and all agree that the fruits are beneficial to health.

About the ways to encourage more people to consume *butiás* and their derived products, a recurring issue was the lack of promotion of the fruit's commercial and nutritional potential, the challenges in legalizing products, and the lack of support from government organizations. Additionally, residents of Giruá highlighted that although the local community identifies with the *Butiá* Fair, few restaurants and bakeries in the region use fruit pulp and almonds in their recipes throughout the year.

Participant 10 (57 years old) mentioned that the Giruá city hall purchases supplies for school meals from local farmers and emphasized that a key long-term step is incorporating *butiás* into children's diets in a more appealing way. According to Severo (2019), when children are introduced to native fruits early on, they develop a habit of consuming them. The author also pointed out that, despite public policies encouraging the use of biodiversity-related products in school meals, the inclusion of native fruits in the menus of municipal schools in Rio Grande do Sul state remains limited.

Another demand from the community is the development of new technologies to facilitate production, such as depulping the fruits and cracking the endocarps. In Giruá, the *EcoButiá* association obtained a physical facility and a depulping machine for processing the pulp; however, they lack the equipment to crack the endocarps, a task still done manually. Many producers avoid this process due to its time-consuming and labor-intensive nature. Some interviewees expressed interest in using the almonds and highlighted their culinary potential and possible applications in the pharmaceutical industry.

Experience with management and observation of *Butia* palm phenology

Regarding the management of *Butia* palm grove, interviewees from the municipality of Quaraí emphasized the importance of fencing cattle for the development of new *Butia* palms. There was no consensus among participants regarding cultural practices, and the discussion about leaf cleaning was recurrent. While some consider pruning essential, arguing that it improves plant health and enhances fruit productivity, others believe it is unnecessary. Additional techniques adopted by some interviewees include using dry leaves as mulch and transplanting plants only during winter to reduce irrigation requirements.

Participant 11 (49 years old) highlighted the need for discussions about tree species management in Giruá, as shading from surrounding vegetation compromises fruit production and reduces the lifespan of *Butia* palm. This occurs because these palm trees are heliophiles, meaning they require intense sunlight exposure for development (Lopes et al. 2015). Giruá is located in a transition area between the Atlantic Forest and the Pampa biome. According to Vargas and Brack (2021), human activities and climate change are driving forest expansion into Pampa grasslands, reducing the biome's species diversity.

The ethnobotanical survey also revealed that interviewees are familiar with the flowering and fruiting periods of *Butia* palms. Reports indicate a noticeable difference in the phenological calendar of *B. yatay* between the studied municipalities, as illustrated in Fig. 8. In Giruá, flowering occurs from June to April, and fruiting from September to May. However, local knowledge indicates that winter flowering only happens during warm spells, and frost causes flower abortion and lack of fruit production. In Quaraí, the phenological cycle is shorter: flowering begins in September and ends in February, while mature fruits appear in February and fruit bunches persist until April.

The phenological cycle differences between the sites in the two municipalities may be attributed to the fact that Giruá participants observe the reproductive cycle more closely, as they rely on the fruits for subsistence. However, the specific soil and climatic conditions of each region may also contribute to this variation. According to IBGE (2002), Giruá's soil is deep and clay-textured, which is characteristic of latosol. Meanwhile, the region of Coatepe in Quaraí has lithologic soil, characterized by a gravelly and rocky texture, which limits vegetative growth and may cause the *Butia* palms to remain in non-reproductive stages for longer periods (Barcelos 2015).

Additionally, most interviewees reported annual variations in *Butia* palms productivity, attributing it to climate fluctuations. In general, they noted that rainy periods during the reproductive phase negatively impact the productivity. According to their observations, the rain can hinder pollination, increase flower

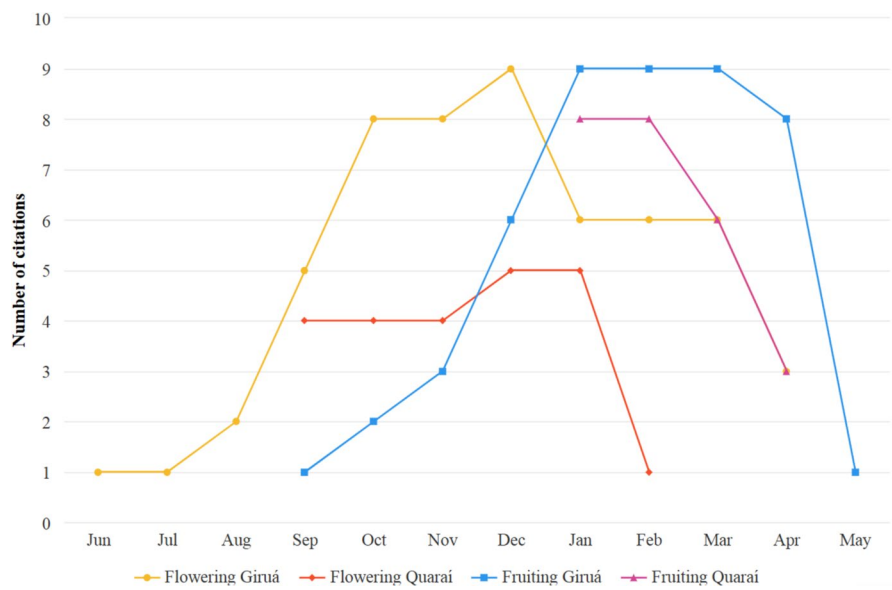

Fig. 8 Local knowledge abuot the reproductive phenology of *Butia yatay* in the municipalities of Giruá and Quaraí, Rio Grande do Sul State, Brazil

abortion, and heighten disease incidence. Similarly, they emphasized that prolonged sunlight exposure during flowering and fruiting is crucial for production, resulting in larger and sweeter fruits.

The fauna associated with *Butia yatay*

The interviewees were asked about which wild and domestic animals have been observed feeding on the fruits of *Butia* palms. As a result, 30 different animals were cited, in addition to birds in general, whose common names the participants could not specify (Table 4).

From the traditional knowledge survey on *B. catarinensis* in the Areais da Ribanceira, municipality of Imbituba, Santa Catarina state, Kumagai and Hanazaki (2013) listed 28 animals that fed on the fruits of this species. Santana et al. (2022) observed 28 mammal species in a *Butia odorata* palm grove in Tapes. At the same location, 53 species of birds were recorded (Glória and Tozetti 2022).

The fruits, flowers, and even the leaves of butiás represent an important food source for various

Table 4 Frequency of citations among the interviewees (n = 17) of animals that feed on the fruits of *Butia yatay*

Common name	Classes	Taxon	Freq. of citations (%)
Ants	Insects	Formicidae	5.9
Bats	Mammals	Chiroptera	5.9
Bem-te-vi	Birds	*Pitangus sulphuratus* Sclater & Salvin	11.8
Birds in general[1]	Birds	Birds	76.5
Canary	Birds	*Sicalis flaveola* Vieillot	5.9
Capybara	Mammals	*Hydrochoerus hydrochaeris* Linnaeus	5.9
Cattle	Mammals	*Bos taurus* Linnaeus	82.4
Chicken	Birds	*Gallus gallus domesticus*	41.2
Curassow	Birds	*Penelope obscura* Humboldt	35.3
Deer	Mammals	*Mazama gouazoubira* Fischer	5.9
Dog	Mammals	*Canis lupus familiaris*	35.3
Fox	Mammals	Canidaesp.	11.8
Horse	Mammals	*Equus caballus* Linnaeus	11.8
Lizards	Reptiles	*Salvator merianae* Duméril & Bibron	11.8
Maricaw	Birds	*Pionus maximiliani* Hellmayr	5.9
Monk parakeet	Birds	*Myiopsitta monachus* Hellmayr	17.6
Opossum	Mammals	*Didelphis albiventris* Lund	11.8
Parrot	Birds	*Psittacara leucophthalmus* Sclater	11.8
Pig	Mammals	*Sus scrofa domesticus*	58.8
Pigeons	Birds	Columbidae	23.5
Rats	Mammals	Muridae	23.5
Rhea	Birds	*Rhea americana* Vieillot	5.9
Saracuras	Birds	*Aramides* spp.	5.9
Sheep	Mammals	*Ovis aries* Linnaeus	35.3
Siriema	Birds	*Cariama cristata* Temminck	11.8
Sparrow	Birds	*Passer domesticus* Stolzmann	11.8
Squirrel	Mammals	*Guerlinguetus ingrami* Thomas	17.6
Thrushes	Birds	*Turdus* spp.	17.6
Turkey	Birds	*Meleagris* sp.	5.9
Weasel	Mammals	*Galictis cuja* Molina	5.9
Wild boar[2]	Mammals	*Sus scrofa* Linnaeus	23.5

[1]The participants could not specify the common name; [2]Invasive exotic species

species of native fauna, such as insects, birds, reptiles, and mammals. This contributes to the balance of ecosystems, as palm trees are typically zoochoric plants, dispersing seeds with the help of animals (Santana et al. 2022). In addition, some animals do not feed on butiás but have an ecological relationship with the ecosystem. This is because *Butia* palm groves ecosystems offer favorable environmental conditions, such as microclimate and structural variation, allowing the establishment of fauna in the area (Barbieri et al. 2015; Geymonant and Rocha 2009; Glória and Tozetti 2022).

Conclusion

The genetic resources of *Butia yatay* are used in various ways in Giruá and Quaraí, Rio Grande do Sul state, Brazil, mainly in food, beverage production, and the handicrafting of utility items and crafts. There is a significant discrepancy between the two sites regarding the number of uses of the *Butia* palms, which can be explained by the support of the public administration in Giruá.

The ethnobotanical knowledge of the communities about the ecology and management of *B. yatay* demonstrates the admiration and respectful relationship that people have with the species; however, the different conservation statuses between Giruá, where active production and support initiatives exist, and Quaraí, where traditional practices are declining due to rural depopulation, highlight the urgent need for localized conservation strategies. Furthermore, these plants are associated with emotional bonds, and the participants highlighted childhood memories, a sense of belonging, personal recognition, and gratitude towards the *Butia* palms.

Competing Interests

The authors declare no competing interests.

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