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Endogenous products of the Cerrado: Understanding the socioeconomic value of pequi (*Caryocar brasiliense* Camb.) through an ethnographic approach

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ABSTRACT

The Cerrado is considered the second largest biome in Brazil and the most biodiverse savanna in the world, due to its varied phytophysionomic characteristics and the diversity of native fruit species. Among them, the pequi (*Caryocar brasiliense* Camb.) stands out, whose fruit, known as pequi, holds significant cultural, nutritional, and socioeconomic relevance. Pequi is composed of various bioactive substances, including carotenoids, such as β -carotene, as well as phytosterols, flavonoids, and phenolic acids. All these classes are scientifically recognized for their antioxidant, anti-inflammatory, and hepatoprotective properties. This study aimed to assess the socioeconomic value of pequi using a qualitative and ethnographic approach, through semi-structured interviews conducted with rural producers from selected regions in the state of Minas Gerais, Brazil. Based on the interviews, frequent consumption of the fruit was evident, especially during the harvest season. The main reasons for consumption were linked to its sensory characteristics, health benefits, and cultural and emotional significance. Participants also emphasized and defended the environmental importance of *C. brasiliense* and expressed concern about deforestation and the ongoing degradation of the biome. Thus, the research reinforces the need to value native species of the Cerrado, as well as the implementation of sustainable practices through public policies that support traditional knowledge, income generation, and biodiversity conservation. Therefore, it became clear that pequi is not only a subsistence resource for many rural producers but also a symbol of regional identity and socio-environmental resistance.

Keywords: Brazilian savanna, Native Species, Sociocultural Valuation.

Produtos endógenos do Cerrado: Compreendendo o valor socioeconômico do pequi (*Caryocar brasiliense* Camb.) por meio de uma abordagem etnográfica.

RESUMO

O Cerrado é considerado o segundo maior bioma brasileiro e a savana mais biodiversa do mundo, devido às suas características fitofisionômicas variadas e diversidade de espécies frutíferas nativas. Entre elas, o pequi (*Caryocar brasiliense* Camb.) se destaca, cujo fruto, denominado pequi, apresenta expressiva relevância cultural, nutricional e socioeconômica. O pequi é composto por diversas substâncias bioativas como carotenoides, um deles, o β -caroteno, além

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da presença de fitoesteróis, flavonoides e ácidos fenólicos. Todas essas classes mencionadas são listadas cientificamente por conferirem propriedades antioxidantes, anti-inflamatórias e hepatoprotetoras. Este estudo teve como objetivo avaliar a valorização socioeconômica do pequi, utilizando uma abordagem qualitativa e etnográfica, por meio de entrevistas semiestruturadas realizadas com produtores rurais de algumas regiões do estado de Minas Gerais, Brasil. Com base nas entrevistas, foi evidente o consumo frequente do fruto, sobretudo, no período da safra. Os principais motivos de consumo foram associados às suas características sensoriais, efeitos benéficos à saúde, além do valor cultural e afetivo. Os participantes também salientaram e defenderam a importância ambiental do *C. brasiliense* e expuseram preocupação com o desmatamento e degradação constante do bioma. Dessa forma, a pesquisa reforça a necessidade de valorização das espécies nativas do Cerrado, bem como a implementação de práticas sustentáveis, através de políticas públicas que apoiem o conhecimento tradicional, a geração de renda e promovam a conservação. Portanto, ficou evidente que o pequi além de ser um recurso de subsistência para muitos produtores rurais, é também um símbolo de identidade regional e resistência socioambiental.

Palavras-chave: Biodiversidade, Espécies Nativas, Valorização sociocultural.

Introduction

In Brazil, there is a diversity of biomes that have unique characteristics and are invaluable to the planet's biodiversity. The largest biome in the world is the Amazon, which stands out not only for its vast territorial extension but also for its rich biodiversity of native species (Flauzino, 2020). However, the Cerrado, known as the Brazilian savanna, also stands out because, as well as being the country's second-largest biome, it is also one of the most biodiverse in terms of fauna and flora (Takahashi et al., 2024).

The Caatinga has vegetation that is more adaptable to the dry season, while the Atlantic Forest biome is wetter and has a high level of endemism. The Pantanal has a very abundant aquatic flora, which is one of the most important factors for this biome. The Pampa also stands out, as it is considered one of the most important temperate ecosystems in the world (Lanfranco et al., 2022).

The Cerrado differs from other ecosystems because, in addition to being an ancient biome covering around 2 million km² (approximately 23% of Brazil's territory), it is rich in fauna and flora. Due to its climate, soil, and relief, it also exhibits modifications according to local climatic conditions (Durigan et al., 2022; Weichert et al., 2024).

The term phytophysognomy portrays the specific type of vegetation in a region, developing its characteristics and appearances, even in different locations (Barros, 2022).

Defined by a phytophysognomic diversity, the Cerrado has various types of vegetation, distributed among forest, savanna, and grassland formations (Weichert et al., 2024).

Of the phytophysognomies of this biome, some are highlighted among the most common, being: campo rupestre, gallery forest, cerrado sentido restrito, dry forest, cerrado, cerrado rupestre, seasonal forest, campo sujo and vereda (Santos et al., 2020).

The extensive analysis of the Cerrado biome reveals not only its territorial, physiognomic, and ecological dimensions that determine its diversity and geographic distribution, but also highlights the importance of conservation and sustainable management to preserve this important biome (Weichert et al., 2024).

Brazil has a high biodiversity in relation to fruits, which are spread across its different biomes (Lima et al., 2021; Farias et al., 2024). Because they exhibit great diversity, high nutritional value, characteristic odor, and flavor, tropical fruits from the Cerrado represent an increased potential in the market (Freitas et al., 2024; Takahashi et al., 2024).

Among the various fruit trees present in the Cerrado, the following stand out: barueiro (*Dipteryx alata*), buritizeiro (*Mauritia flexuosa* L.), mangabeira (*Hancornia speciosa*), cagaiteira (*Eugenia dysenterica*), araticunzeiro (*Annona crassiflora*), and pequi (*Caryocar brasiliense*). These fruits can be marketed in different ways, either in natura, as products (jellies, ice creams, sweets, juices, flours, etc.) or through handicrafts (Bauer et al., 2022; Mariano et al., 2022).

The pequi tree (*Caryocar brasiliense* Camb.) is a fruit tree that receives great prominence in the Cerrado, being commonly cultivated in the Southeast, Northeast, and Midwest regions, it is an essential source of sustenance and income for families living in the Cerrado. This species is commonly cultivated in the Southeast, Northeast and Central-West regions of Brazil (Santos et al., 2020; Santos et al., 2024).

It belongs to the Caryocaraceae family, and its fruits, known as pequi, are made up of bark, external mesocarp, where they can have one or more pits that are covered by a yellowish pulp (internal mesocarp), which is fleshy, rich in oil, and is usually the most used part in cooking (Garcia et al., 2024; Weichert et al., 2024). The term pequi (bark with thorns), from the Tupi language, gets its name because, between the edible pulp and the almond, there is a layer of very thin thorns (Weichert et al., 2024; Garcia et al., 2024).

Pequi contains a large amount of compounds such as organic acids, sugars, flavonoids, coumarins, and tannins, which promote health through antioxidant activity and anti-inflammatory, antibacterial, antifungal, antiviral, and antitumor properties (Carneiro et al., 2023; Silva et al., 2023). In addition, pequi has a high degree of carotenoids, which are substances responsible for coloring, and are rich in provitamin A. Because of its high protein content, this fruit is often referred to as the 'meat of the Cerrado' (Bruno Filho et al., 2021).

Several Volatile Organic Compounds (VOCs) found in pequi are associated with its sensory characteristics, which were pointed out by interviewees as attractive factors for consuming the fruit. Studies have identified various chemical classes in pequi's pericarp, such as ketones, alcohols, esters, aldehydes, terpenes, and hydrocarbons, which contribute to the fruit's unique flavour and functional properties (Santos et al., 2020; Magalhães & Ferro, 2020; Marques et al., 2023).

This chemical diversity reflects pequi's potential for use in industrial sectors such as food, cosmetics, and pharmaceuticals, as well as contributing to its bioactive properties. Understanding this VOC profile also enables the development of innovative products and the valorisation of the species (Rodrigues et al., 2023; Melo et al., 2024).

According to the Brazilian Institute of Geography and Statistics (IBGE), the extraction of pequi in Brazil in 2021 was 74 thousand tons, with Minas Gerais being the state responsible for half of the production. From this, the relevance of pequi is remarkable (Instituto Brasileiro de Geografia e Estatística [IBGE], 2021).

This importance is due to the benefits assured to the population, such as food and nutritional security, and its unique characteristics, its different flavor and aroma, in addition to generating income for producers. Also, pequi is part of rural culture and tradition, being part of the

history of several people, and can be found in music, arts, poetry, and handicrafts (Oliveira et al., 2024).

The Cerrado remains conserved due to the care and resistance of its inhabitants, housing more than 20 million Brazilians living in harmony with the environment. The native peoples and the traditional communities of quilombolas, geraizeiros, coconut breakers, extractivists, pequi collectors, among many others, represent the sociobiodiversity of the biome (Colli et al., 2020; Ribeiro et al., 2020).

The PNPCT (National Policy for the Sustainable Development of Traditional Peoples and Communities) decrees that traditional peoples and communities are culturally differentiated groups that recognize themselves as such, having their own forms of social organization and occupying and using natural resources for cultural, social, religious, ancestral, and economic reproduction through knowledge passed down from generation to generation (Decreto nº 6.040, 2007).

Therefore, the objective of this study was to understand the socio-economic significance of pequi (*Caryocar brasiliense*) as an endogenous product of the Cerrado, based on a qualitative ethnographic approach supported by semi-structured interviews with rural producers.

Methodology

The present study was characterized by a qualitative approach, in order to understand the commercialization, perception and knowledge of rural producers in the Cerrado regarding the pequi fruit. Qualitative research offers several advantages, including the depth of understanding of the phenomena studied, flexibility in the data collection process, and the ability to explore subjective meanings and experiences (Bernard, 2006). In addition, it allows for rich and detailed analysis, which can reveal nuances that quantitative research may miss. This approach included the ethnographic method and data collection through semi-structured interviews, which allowed flexibility and adaptability to the individualities of each interviewee (Oliveira et al., 2023).

Preparation of the Interview Script

A script was drawn up to address questions about various categories, including: the profile of rural producers, the commercialisation of pequi products, knowledge and perception, socio-cultural

importance and future prospects for the sustainability of fruit species in the Cerrado, with an emphasis on pequi.

Procedures and data collection

The methodological procedures followed five main sequential steps:

Step 1: Definition of selection criteria and target audience: The target audience consisted of 13 rural producers from different regions of Minas Gerais. Of these, 11 were women and 2 men, aged between 42 and 60 years. The main inclusion criterion was current or past involvement with the cultivation, harvesting, or commercialization of pequi. This selection aimed to ensure a diversity of experiences and perspectives, enriching the research and highlighting the plurality of relationships with the fruit. It is noteworthy that all interviewees had their identities anonymized in accordance with ethical research principles.

Step 2: Construction of the interview script: A semi-structured script was developed addressing five main thematic categories: (a) producer profiles, (b) commercialization practices, (c) knowledge and perceptions about pequi, (d) socio-cultural relevance, and (e) future prospects regarding the sustainability of native fruit species.

Step 3: Data collection: Semi-structured interviews were conducted between February and April 2024, either in person or virtually via the Google Meet platform, depending on participant availability and access conditions. Each interview lasted approximately 20 minutes. All participants signed the informed consent form, and interviews were audio or video-recorded. In parallel, ethnographic observations were conducted at fairs and community events where producers sell their products. These visits enabled the recording of field notes and contextual observations, enriching the data with *in situ* interactions.

Step 4: Data transcription and organization: All interviews were manually transcribed. The data were anonymized, respecting ethical principles of research involving human subjects, in accordance with Resolution CNS No. 510/2016 (Resolução nº 510, 2016).

Data analysis

The empirical material was analyzed through thematic content analysis, also referred to by some authors as dialogical thematic analysis (Creswell, 2007). This technique was chosen for its effectiveness in identifying recurring themes, symbolic expressions, and discursive strategies within participants' narratives. The analysis sought to interpret not only patterns of meaning but also idiomatic expressions and analogies reflecting the lived experiences and socio-cultural references of the producers.

As a complementary tool, the online *Word Cloud Generator* was used to visualize the frequency of the most mentioned terms in each interview. These visual representations aided the initial categorization of data, which was then systematized in an Excel spreadsheet, enabling data triangulation across interviews, field notes, and thematic categories.

Results and discussion

In Figure 1, it is possible to observe the pequi tree, typical of the state of Minas Gerais, Brazil, with its highlighted flowers, whole and cut fruit, as well as its seeds and nuts.

Through the observation of this figure, one can gain a detailed view of the characteristics of this species, particularly the thorns present in the nut, highlighting the richness of biodiversity in the Cerrado biome.



Figure 1. The pequi tree (a, b), its flowers (c, d), whole pequis (e), cut pequis (f), pequi stones (g), stone cut in half, with the presence of thorns (h), and pequi nuts (i). **Source:** Authors (2024).

The interviews were conducted with rural producers from different regions of Minas

Gerais, Brazil, belonging to the Cerrado. Figure 2 shows the delimitation of these regions.

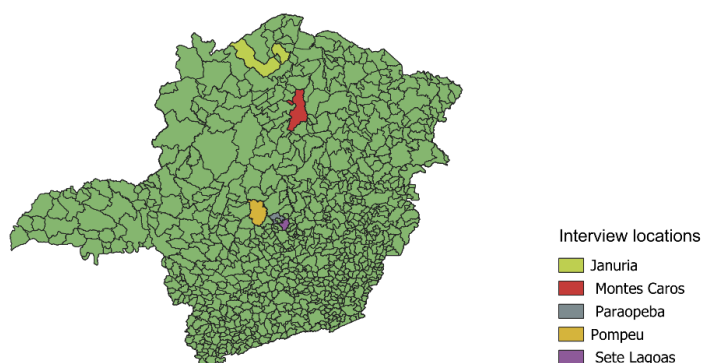


Figure 2. Representation of the map of the state of Minas Gerais, Brazil, highlighting the location of the Cerrado (a) and the interviewees' municipalities (b). **Source:** Authors (2024).

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Regarding the category "*Perception and motivation*", it was observed that all interviewees consumed pequi frequently, especially during the harvest season (November to February). When asked about the reasons that favored this consumption, most of the producers interviewed associated the sensory characteristics of the fruit (flavor and aroma) and their knowledge about the beneficial properties to human health.

One of the interviewees from the region of Montes Claros/MG reported:

"Lately, we are consuming it all year round, before it was only during the harvest period, but now, from the processing work that we have here, with our association, we already have it in stock and we can consume it all year round."

The same interviewee pointed out that the factor that led him to consume and sell the fruit was related to the flavor and the cultural and regional aspects of where he lives. The interviewee reported that in Montes Claros/MG, the region where he lives, there is a "competition" in which the participant who eats the pequi faster receives a prize at the end. In this celebration, a fair is held where various food and handicraft products made from the pequi are exhibited.

The narrative presented earlier demonstrates not only the gastronomic importance of the fruit but also its cultural relevance in the region. The "competition", in which participants must eat pequi quickly, emphasizes how the fruit is considered a cultural and entertainment element that fosters the strengthening of community ties in support of local traditions.

The organization of a fair that highlights food and handicraft products made with pequi is an exemplary illustration of how regional culture can be celebrated and marketed. In addition to encouraging the local economy, it also provides environmental

education to people about the various uses of pequi.

Figure 3 shows some of the products produced and marketed by the interviewed producers.

Another producer, belonging to the region of Pompéu/MG, emphasized that they consume the fruit, mostly, at harvest time; however, they store the fruit to consume throughout the year as well. In the region of Sete Lagoas/MG, a producer reported that she consumed pequi frequently; however, she has currently reduced her consumption of the fruit. This same producer stated:

"In addition to having health benefits, I think it has and is proven by the use, for example, of its oil. And so, it is a very tasty fruit, we consume and make several very tasty dishes with it, so the pequi is used a lot and I like it a lot."

Pequi has several bioactive substances (Figure 4), mainly with antioxidant properties (Brito et al., 2022; Melo et al. 2024, Santos et al., 2020). Even though they do not have the scientific knowledge of these fruits, the interviewees recognize the beneficial effect of consuming pequi.

As shown in Figure 4, which illustrates some of the chemical constituents of pequi, there is a presence of carotenoids, pigments responsible for the yellow coloration of the fruit, as well as relevant antioxidant properties that help prevent degenerative diseases and support eye health (Carneiro et al., 2023; Delalibera et al., 2024).

Pequi also contains phytosterols, which assist in reducing blood cholesterol levels, thereby promoting cardiovascular health. Furthermore, the flavonoids present in the fruit play a significant role due to their antioxidant and anti-inflammatory properties, helping to protect cells against oxidative stress and improving blood circulation, which may contribute to lower blood pressure (Santos et al., 2022; Carneiro et al., 2023).



Figure 3. Pequi-based products produced and marketed by the producers interviewed: pequi nuts (a, i), pequi oil (b), frozen pequi pulp (c), pequi cream (d), pequi flour (e, j), pequi pickles (f), pequi alcoholic beverages (g), pequi nuts (h), various pequi products (k), pequi sauce (l). **Source:** Authors (2024).

In addition, the fruit is rich in tocopherols, such as vitamin E, which protect cells from damage caused by free radicals, benefiting skin health and the immune system, as well as contributing to the prevention of cardiovascular diseases and cancer. Moreover, phenylpropanoids also exhibit anti-inflammatory and antioxidant properties,

enhancing the therapeutic efficacy of the fruit and aiding in the prevention of numerous diseases (Denger et al., 2020; Martins et al., 2025).

Together, these substances make pequi a valuable health food, highlighting its nutritional and medicinal importance. The rich chemical composition of pequi makes it a fruit with a

distinctive flavor that is highly nutritious and beneficial for health (Brito et al., 2022; Costa et al., 2024).

Thus, regular consumption of this fruit can contribute to disease prevention, as well as promote a balanced and healthy diet. However, the

appreciation of pequi in traditional cuisine can encourage more sustainable practices and raise awareness about the need to preserve Cerrado, ensuring that these benefits remain accessible for future generations (Caetano et al., 2024; Freitas et al., 2024).

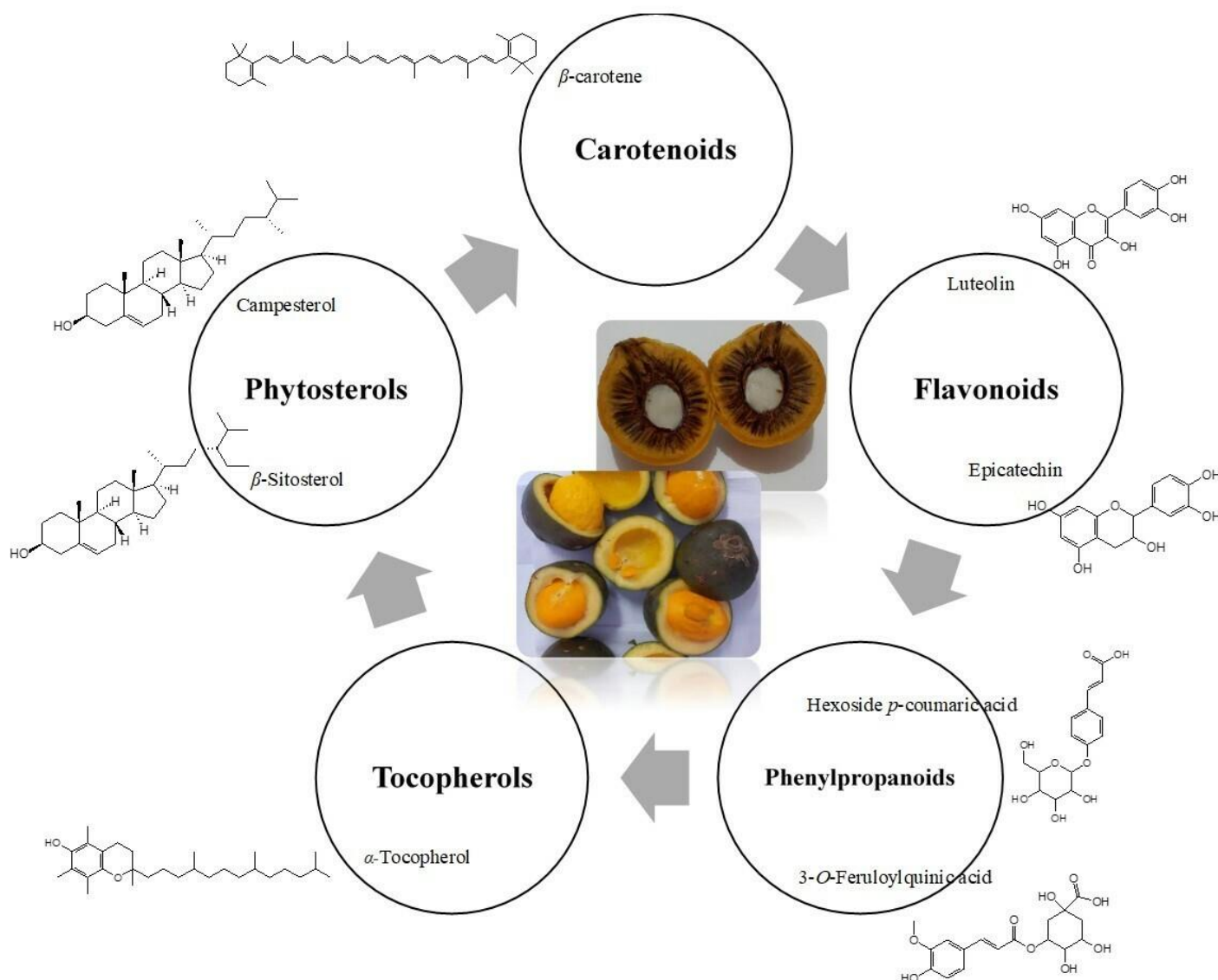


Figure 4. Main substances identified in pequi. **Source:** Authors (2024).

As shown in Figure 4, among the bioactive components found in pequi, carotenoids stand out, such as β -carotene, the precursor to vitamin A. These compounds play a crucial role in neutralising free radicals, contributing to cellular protection against oxidative stress, as well as promoting ocular and immune health. Their presence highlights pequi's antioxidant potential, making it an important food in the fight against oxidative

damage associated with ageing and various chronic diseases (Carneiro et al., 2023).

Phytosterols such as campesterol and β -sitosterol, also found in pequi, are associated with lower blood cholesterol levels, which can help prevent cardiovascular diseases. These compounds interfere with the intestinal absorption of cholesterol, reducing concentrations of LDL in the bloodstream and, consequently, favouring cardiovascular health (Salehi et al., 2021). This

benefit reinforces the importance of consuming pequi as part of a balanced diet.

Among the phenolic compounds in this fruit, flavonoids stand out, such as luteolin and epicatechin, which have a marked antioxidant and anti-inflammatory effect. Studies widely documented in the literature suggest that these compounds play an important role in preventing chronic diseases such as diabetes, obesity, and malignant neoplasms. In addition, flavonoids have neuroprotective properties, contributing to the mitigation of damage associated with brain ageing and neurodegenerative diseases (Brito et al., 2022; Melo et al., 2024).

Given the vast chemical and bioactive composition of pequi, it is worth highlighting the phenolic acids and cinnamic acid derivatives, such as p-coumaric acid and 3-O-feruloilquinic acid, which belong to the phenylpropanoid group. These compounds have demonstrated antimicrobial and hepatoprotective activities, as well as modulating inflammatory processes. The presence of tocopherols, such as α -tocopherol (vitamin E), complements this bioactive profile, offering protection against premature ageing. Thus, the diversity of compounds present in pequi not only reinforces its health benefits but also emphasises the importance of its consumption and sustainable cultivation (Guerra et al., 2023; Monteiro-Alfredo et al., 2023).

Still on the issue of consumption, a producer from the Pompéu-Minas Gerais region emphasized that she frequently consumes the fruit and likes it a lot. The consumption of the fruit reminds her of her childhood, when her mother cooked the pulp of the pequi and added sugar until it thickened, referring to it as a "pequi chocolate". The pequi chocolate produced sought out the aromatic intensity and characteristic flavour of pequi combined with sweetness and creaminess, with the aim of obtaining a unique experience reminiscent of the rich flavours of traditional chocolate (Mazzinghy et al., 2024).

In the category of "*Perspective and sustainability*", most interviewees claimed that the pequi is considered environmentally sustainable.

When asked why they had this perspective, some reported: "Because if you preserve the pequi tree, you are preserving some animals that consume the fruit as well", or even:

"Of course, from the moment you remove the fruits, you are preserving that biome, now from the moment you cut it, you no longer have that tree".

The interviewee's remarks prompt reflection on a relevant dilemma regarding the sustainable use of natural resources and environmental preservation. By harvesting the fruits of a tree, such as the pequi, it becomes possible to benefit from the economic and nutritional advantages of the fruit while also contributing to the preservation of the species to which the tree belongs. This highlights a sustainable management practice that can generate benefits for both local communities and the ecosystem (Carneiro et al., 2023; Melo et al., 2024).

On the other hand, cutting down these trees to obtain wood or expand agriculture leads to a significant loss for the biome. It not only eliminates a source of fruit but also harms the surrounding ecosystem, including animal species that depend on these trees for shelter and food, ultimately compromising biodiversity (Klink et al., 2020; Sobral et al., 2024).

Therefore, this situation reinforces the importance of seeking a balance between economic development and environmental conservation (Silva et al., 2024; Melo et al., 2024).

All interviewees expressed concern about the deforestation of native trees in the Cerrado, especially the pequi tree.

Although the cutting of pequi trees is prohibited, supported by Law No. 20,308, of July 27, 2012 (Lei nº 20.308, 2012) and by Ordinance No. 32, of January 23, 2019 (Portaria nº 32, 2019), the species is still threatened.

When asked if the pequi has the potential to be used in the development of medicines and other foods, many pointed out that it does, with emphasis on one interviewee who informed:

"Despite the taste and the strong smell, I believe so. Now you see that everyone is in contact with natural remedies, more natural food, so there is already a good current in this sense."

In addition to emotional memories and its connection with nature, the consumption of pequi emerges as a form of cultural resistance and appreciation of traditions. In an increasingly interconnected world, where industrialized foods stand out, the appreciation of this fruit demonstrates a reaffirmation of regional identity (Bratman et al., 2021).

However, the holding of festivals and fairs contributes not only to expanding and making this cultural connection stronger, but also to stimulating sustainable tourism, attracting visitors (Guerra et al., 2023; Simões et al., 2024).

Figure 5 below shows the "word cloud" generated from the transcription of the interviews.



Figure 5. Word Cloud of Terms Extracted from the Interviews. Source: Authors (2024).

Figure 5 provides a word cloud centred on the pequi fruit, in which terms related to consumption, commercialisation, income, and sustainability reflect the social, economic, and environmental relevance of this product.

Words such as 'family', 'product', 'oil' and 'nut' reflect the relevance of the fruit as a source of income for communities, while terms such as 'environment', 'preservation' and 'sustainability' highlight concerns about the conservation of the Cerrado biome, where pequi is widely grown and harvested.

In addition, the presence of the words 'production', 'sale', 'collection' and 'commercialisation' suggests the role of pequi in integrating regional production chains. The inclusion of words such as 'harnessing', 'transformation' and 'utilisation' highlights the multiple ways in which the fruit and its by-products can be used, such as oils, processed foods (yoghurts, balls) and medicines. This reinforces the need to develop sustainable strategies for its use, combining cultural valorisation, product innovation and benefits for communities.

In short, the potential of pequi in the areas of health and food presents innovations and expansion of the local economy. In this way, studies on the bioactive compounds present in this species reveal its rich bioactive composition (Lima et al., 2020; Melo et al., 2024).

Conclusion

The study highlights the importance of pequi as a crucial element within the social, economic, and environmental context of the Cerrado biome. Through qualitative and ethnographic analyses conducted with rural producers, relevant aspects were identified that reflect the impact of this fruit on the regions of Minas Gerais.

Pequi emerges as a valuable resource for the local economy, due to its diversification and applications, particularly in food products and handicrafts. This not only contributes to income generation but also strengthens the appreciation of local culture. During the harvest season, fruit consumption intensifies. These fruits are rich in nutrients and bioactive compounds, which provide beneficial health effects and contribute to the development of new products.

In this context, the study demonstrated through interviews that implementing and strengthening public policies to promote this fruit species can generate broad benefits, including the preservation of Cerrado biodiversity and increased income for local communities.

Therefore, pequi is not only an economic resource but also a symbolic fruit that connects the inhabitants of the Cerrado to their biome, exemplifying a model of sustainable development.

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