



Mangaba: botanical characterization, production and processing systems: a review

Mangaba: caracterização botânica, sistemas de produção e processamento: uma revisão

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Fellipe Kennedy Alves Cantareli

PhD student in Agronomy

Institution: Universidade Federal de Goiás

Address: Goiânia – Goiás, Brazil

E-mail: cantareli@discente.ufg.br

Orcid: <https://orcid.org/0000-0003-2728-9804>

Gessiele Pinheiro da Conceição

Master's student in Agronomy

Institution: Universidade Federal de Goiás

Address: Goiânia – Goiás, Brazil

E-mail: gessielepca@discente.ufg.br

Orcid: <https://orcid.org/0009-0004-8630-3957>

Julia Moraes Gomes

Master's student in Agronomy

Institution: Universidade Federal de Goiás

Address: Goiânia – Goiás, Brazil

E-mail: julia.sempasementes@gmail.com

Orcid: <https://orcid.org/0009-0008-7641-6762>

Flavia Feliciano da Costa Silva

PhD student in Agronomy

Institution: Universidade Federal de Goiás

Address: Goiânia – Goiás, Brazil

E-mail: flaviafelicianoagro@yahoo.com.br

Orcid: <https://orcid.org/0009-0003-5330-6185>



Gleice Alves de Sousa

PhD student in Agronomy

Institution: Universidade Federal de Goiás

Address: Goiânia – Goiás, Brazil

E-mail: gleice.sousa@ifg.edu.br

Orcid: <https://orcid.org/0009-0002-2321-3140>

Eli Regina Barboza de Souza

PhD in Agronomy

Institution: Universidade Federal de Goiás

Address: Goiânia – Goiás, Brazil

E-mail: eliregina@ufg.br

Orcid: <https://orcid.org/0000-0001-6225-6122>

Jade Cristynne Franco Bezerra

PhD in Forest Science

Institution: Universidade Estadual Paulista Julio de Mesquita Filho (UNESP)

Address: Botucatu – São Paulo, Brazil

E-mail: jadefranco9@gmail.com

Orcid: <https://orcid.org/0000-0001-6844-0131>

Bruna Ferreira dos Anjos

PhD student in Agronomy

Institution: Universidade Estadual Paulista Julio de Mesquita Filho (UNESP)

Address: Botucatu – São Paulo, Brazil

E-mail: bruna.anjos07@gmail.com

Orcid: <https://orcid.org/0000-0001-6905-1656>

Marco Antônio Adorno Cardoso

Master in Agronomy

Institution: Universidade Federal de Goiás

Address: Goiânia – Goiás, Brazil

E-mail: marcoantonioadornocardoso@gmail.com

Orcid: <https://orcid.org/0000-0002-0277-3168>

Kamilla Rasmussem Mendonça

Graduated in Agronomy

Institution: Centro de Educação Superior Mais

Address: Inhumas – Goiás, Brazil

E-mail: kamilla.rasmussem@discente.ufg.br

Orcid: <https://orcid.org/0009-0008-8630-7607>

ABSTRACT

The mangaba (*Hancornia speciosa* Gomes) is a native fruit tree widely distributed across the Cerrado, Caatinga, Atlantic Forest, and Amazon biomes. It stands out for its high nutritional value, functional properties, and sociocultural relevance, especially in Northeastern Brazil. Its fruits are rich in vitamins, minerals, and bioactive compounds such as phenolic compounds and



carotenoids, known for their antioxidant activity. Despite its potential for agroindustry, pharmacology, and cosmetics, economic exploitation remains predominantly extractive and is limited by the lack of commercial cultivars, morphological variation among populations, and challenges in genetic conservation. This review compiles information on the botanical characterization, phenology, geographic distribution, cultivation systems, and processing methods of mangaba, highlighting its value as a strategic agroecological resource. It also discusses scientific advances related to its conservation, sustainable use, and value addition through the development of new products. Based on the information presented in this review, it is evident that public policies, genetic improvement programs, and sustainable management initiatives are needed to promote the rational expansion of cultivation and the full utilization of the species' potential.

Keywords: *Hancornia speciosa*, mangaba, cerrado fruits, conservation technologies.

RESUMO

A mangaba (*Hancornia speciosa* Gomes) é uma frutífera nativa amplamente distribuída nos biomas Cerrado, Caatinga, Mata Atlântica e Amazônia, destacando-se pelo alto valor nutricional, propriedades funcionais e relevância sociocultural, especialmente no Nordeste brasileiro. Seus frutos apresentam composição rica em vitaminas, minerais e compostos bioativos, como compostos fenólicos e carotenoides, com reconhecida atividade antioxidante. Apesar de seu potencial para a agroindústria, farmacologia e cosmética, a exploração econômica ainda é predominantemente extrativista e limitada pela ausência de cultivares comerciais, variações morfológicas entre populações e desafios na conservação genética. Esta revisão reúne informações sobre a caracterização botânica, fenologia, distribuição geográfica, sistemas de cultivo e formas de processamento da mangaba, evidenciando seu valor como recurso agroecológico estratégico. Também são discutidos os avanços científicos relacionados à sua conservação, uso sustentável e agregação de valor por meio do desenvolvimento de novos produtos. Diante das informações obtidas nesta revisão, é possível concluir que há a necessidade de criação de políticas públicas, programas de melhoramento genético e iniciativas de manejo sustentável para promover a expansão racional do cultivo e o aproveitamento pleno do potencial da espécie.

Palavras-chave: *Hancornia speciosa*, mangaba, frutos do cerrado, tecnologias de conservação.

RESUMEN

La mangaba (*Hancornia speciosa* Gomes) es una fruta nativa ampliamente distribuida en los biomas Cerrado, Caatinga, Mata Atlántica y Amazonía. Se destaca por su alto valor nutricional, propiedades funcionales y relevancia sociocultural, especialmente en el noreste de Brasil. Sus frutos presentan una composición rica en vitaminas, minerales y compuestos bioactivos, como compuestos fenólicos y carotenoides, con reconocida actividad antioxidante. A pesar de su potencial para la agroindustria, la farmacología y la cosmética, su explotación económica sigue siendo predominantemente extractiva y está limitada por la ausencia de cultivares comerciales, las variaciones morfológicas entre poblaciones y los desafíos en la conservación genética. Esta revisión reúne información sobre la caracterización botánica, fenología, distribución geográfica, sistemas de cultivo y formas de procesamiento de la mangaba, evidenciando su valor como recurso agroecológico estratégico. También se discuten los avances científicos relacionados con su conservación, uso sostenible y agregación de valor mediante el desarrollo de nuevos



productos. A partir de la información obtenida en esta revisión, se concluye que existe la necesidad de crear políticas públicas, programas de mejoramiento genético e iniciativas de manejo sostenible para promover la expansión racional del cultivo y el pleno aprovechamiento del potencial de la especie.

Palabras clave: *Hancornia speciosa*, mangaba, frutos del cerrado, tecnologías de conservación.

1 INTRODUCTION

Among the native plant species of the Cerrado biome, those that produce edible fruits stand out due to their extreme importance for the local fauna and for extractivist communities that benefit from the maintenance and preservation of these species. These fruit species, with exotic characteristics, possess peculiar and intense sensory attributes (Morzelle *et al.*, 2015).

The mangaba (*Hancornia speciosa*) is a widely cultivated and highly appreciated fruit in Northeastern Brazil due to its pleasant sensory characteristics, such as its acidic flavor and aroma. It is mainly consumed fresh or as juice (Chaves Almeida *et al.*, 2022). This native fruit has a composition that is extremely rich in nutrients and displays considerable antioxidant activity (Oliveira Filho *et al.*, 2023).

There is great interest in the fruits of *H. speciosa*, which are rich in potassium, iron, zinc, ascorbic acid, phenolic compounds, and carotenoids such as β -carotene, β -cryptoxanthin, α -tocopherol, and α -, β -, and γ -tocotrienols (Cardoso *et al.*, 2014). Therefore, studying native fruits like mangaba is essential for generating detailed information about this raw material and presenting it as a natural alternative source of bioactive compounds (Guimarães *et al.*, 2023).

Despite its economic and ecological importance, native mangabeira trees have been under pressure due to deforestation in Cerrado areas, leading to a sharp decline in their populations. This contributes to the increasing rarity of this native species of the Cerrado and coastal tablelands in its natural habitat (Oliveira *et al.*, 2014).

Aiming to highlight the relevance of this species as a potential source of agroeconomic resources, as well as to emphasize its diverse chemical composition and various possible applications, we conducted a literature review addressing its botanical, ecological, agronomic, and industrial aspects.



2 REVIEW METHODOLOGY

This literature review was conducted with the aim of gathering, organizing, and critically analyzing the available information on mangabeira (*Hancornia speciosa* Gomes), addressing its botanical, ecological, agronomic, and industrial aspects. The selection of sources was based on criteria of scientific relevance, up-to-dateness, and alignment with the study's scope.

Searches were carried out between February and April 2025 in the Scopus, Web of Science, ScienceDirect, SciELO, and Google Scholar databases. Combinations of the following descriptors were used in Portuguese, English, and Spanish: *Hancornia speciosa*, mangaba, native fruits of the Cerrado, bioactive compounds, fruit pulp, genetic conservation, fruit processing, and traditional uses.

The review included scientific articles, literature reviews, dissertations, theses, and technical documents published between 2000 and 2024, with a focus on morphological, ecological, agronomic, and technological aspects of *H. speciosa*. Studies with incomplete data, duplicates, lack of access to the full text, or whose focus was not directly related to the species were excluded.

The initial screening was based on titles and abstracts. Subsequently, full texts were assessed to verify their relevance to the review's scope. The extracted information was thematically organized into the following categories: (a) botanical characterization and phenology; (b) geographic distribution and ecological aspects; (c) cultivation systems and conservation; (d) processing and industrial applications.

The critical analysis considered major scientific advances, knowledge gaps, and the species' potential, highlighting its importance in the context of biodiversity, food security, and sustainable bioeconomy.

3 LITERATURE REVIEW

3.1 CLASSIFICATION AND BOTANICAL ASPECTS

The mangabeira (*Hancornia speciosa* Gomes) is a fruit tree native to Brazil, scientifically classified as belonging to the kingdom Plantae, division Magnoliophyta, class Magnoliopsida,



order Gentianales, family Apocynaceae, and genus *Hancornia*. It is a latex-producing fruit tree native to Brazil that grows spontaneously in the Cerrado, Coastal Tablelands, and Lowland Coastal areas of the Northeast, where almost all of the country's production is concentrated (Silva *et al.*, 2013).

It is popularly known by several names, including mangaba, mangabeira, mangabinha-do-norte, mangava, and mangaveira. The word *mangaba* is of Indigenous origin and means "something good to eat." It is one of the fruits richest in iron and is also a good source of vitamin C (Carvalho, 2006).

According to Silva (2013), *Hancornia speciosa* presents itself in botanical varieties that differ in certain morphological characteristics, mainly in the leaves and flowers, and are classified as follows:

- a) *H. speciosa* var. *speciosa*: petiole 9.0 mm to 15.0 mm long; blade about 6 cm long and 2.0 cm wide; glabrous; glabrous pedicels; glabrous calyx or rarely pubescent on the outside;
- b) *H. speciosa* var. *maximiliani*: blade slightly shorter and narrower, and petiole slightly shorter than the typical variety; petiole approximately 8.0 mm long; blade 5.0 cm to 6.0 cm long and 2.0 cm to 2.5 cm wide;
- c) *H. speciosa* var. *cuyabensis*: petiole approximately 3.0 mm long; blade 4.0 cm to 10.0 cm long and 1.5 cm to 3.0 cm wide; calyx glabrous on the outside; large, glabrous corolla on the outside;
- d) *H. speciosa* var. *lundii*: petiole 3.0 mm to 5.0 mm long; blade 5.0 cm to 7.0 cm long and 3.0 cm wide; pubescent pedicels; calyx with bristly-pubescent exterior; corolla with externally pubescent lobes;
- e) *H. speciosa* var. *gardneri*: short petiole as in var. *lundii*; blade 7.0 cm to 10.0 cm long and about 4.0 cm wide, glabrous on the dorsal side or pubescent on the underside of the midrib;
- f) *H. speciosa* var. *pubescens*: densely pubescent branches; short, pubescent petiole as in *gardneri* and *lundii* varieties; pubescent blade on the underside, 6.0 cm to 12.0 cm long and 3.0 cm to 6.0 cm wide; large corolla with bristly-pubescent lobes and externally pubescent tube.



Embrapa Tabuleiros Costeiros (2016) defines the mangabeira as a medium-sized tree, reaching up to 15 meters in height, with slow growth and a broad crown. It usually has a single, twisted or straight trunk with an average diameter of 20 to 30 cm. The branches are well-formed, slanted, and numerous; when young, they are purplish, smooth up to one year of age, slightly angular, short, sparsely leaved, and flower-bearing at the apex. The stem is rough and coarse, with two to three bifurcations at an average height of 40 to 50 cm from the base. The plant exudes a white or pale pink latex.

The leaves are generally simple, opposite, evenly spaced, elliptic, oblong or elliptic-lanceolate at both ends, and may be glabrous or pubescent. The inflorescence consists of two to four, sometimes up to five, hermaphroditic bell-shaped flowers, occasionally solitary, white and later pink or yellow, tubular, and fragrant.

The fruit is a berry type, ellipsoidal or rounded, measuring between 2.5 to 6.0 cm in length, with a yellow exocarp featuring reddish spots or streaks. The pulp has a mild, sweet, fleshy, mucilaginous, and acidic taste, generally containing between two and 15, or even up to 30, flattened seeds, measuring 7 to 8 mm in diameter, light brown and rough (Ganga *et al.*, 2009; Venturini Filho, 2010).

In general, the mangaba fruit is composed of approximately 77% pulp, 12% seeds, and 11% peel (Narain, 1990). These proportions may vary depending on the mother plant and region of origin. For instance, Aguiar Filho *et al.* (1998) observed that fruits from the Northeast presented an average of 86.5% pulp, 9.0% seeds, and 4.5% peel.

3.2 PHENOLOGY

The Cerrado encompasses a wide range of ecosystems with highly diverse landscape and ecological characteristics, and is primarily recognized for the predominance of **cerrado sensu lato** in its various physiognomic forms (Coutinho, 2006). This mosaic also includes other formations such as gallery and swamp forests, **veredas** (palm swamps), and humid grasslands, all of which contribute to its significant environmental heterogeneity and floristic diversity (Tannus; Assis, 2004).

In the Cerrado, the mangabeira (*Hancornia speciosa*) blooms from August to October. Generally, there is one main fruit harvest per year, occurring from October to December (Silva



et al., 2001) or from November to December, with only a few off-season fruits found outside of this period (Ferreira, 1973). According to Lima; Scariot (2010), mangabeira flowers appear mainly from August to November, but there are many early blooms, which result in fruit being present on trees almost year-round, depending on the region. However, the majority of fruit production occurs between October and April, as seen in the Cerrado region of Mato Grosso do Sul, with a peak in April and May (Bianco; Pitelli, 1986).

Along the northeastern coast, mangabeira typically exhibits two flowering and fruiting periods per year. Vieira Neto (1994) reported that fruiting occurs nearly year-round, with peak production between November and June. Bezerra *et al.* (1997) determined the fruiting season in Pernambuco to be from December to May, with the highest concentration between January and April.

Mangabeira flowering and fruiting are irregular, varying with the season, from year to year, among different regions, and even among trees in the same area. Despite this variation, fruit collection generally follows a specific seasonal pattern. In northern Minas Gerais, for example, fruit is collected from October to January. In Sergipe, there is a summer harvest from December to April, and a winter harvest from May to July. In Bahia, harvesting occurs from November to April (Lima; Scariot, 2010). In the Cerrado region, flowering occurs from July to September, with fruit ripening between September and December; harvesting begins in November or December and can extend through May or June (Silva *et al.*, 2017; Vieira Neto, 2002).

The mangabeira is self-incompatible, as demonstrated in a study by Darrault; Schlindwein (2006), requiring genetically distinct individuals and specific pollinators for successful cross-fertilization and fruit production. Increased pollinator activity leads to higher fruit set, larger fruits, and a greater number of seeds. A total of 33 species of floral visitors have been recorded on mangaba flowers, including bees (Euglossini and Centridini) and butterflies (Nymphalidae and Hesperiiidae), generally species with long mouthparts.

3.3 ECOLOGICAL ASPECTS AND GEOGRAPHICAL DISTRIBUTION

The mangaba tree (*Hancornia speciosa* Gomes) is a species typical of tropical climates, best adapted to temperatures ranging from 24 to 26 °C. Its ideal water requirement varies from 750 mm to 1,600 mm of well-distributed annual precipitation, with some tolerance to drought



periods. Naturally, it is found in sandy or sandy-clay soils, generally acidic, with low fertility, low organic matter content, low water retention capacity, and often in rugged and stony terrains that are unsuitable for conventional agriculture (Silva Júnior *et al.* 2016).

The main non-timber forest product derived from the mangaba tree is its fruit, which is widely used by traditional communities. These communities consume the fresh fruit and market it in various forms, such as pulp, sweets, and liqueurs. Despite its pleasant sensory properties and potential as a nutritious and functional food, the mangaba tree is still underexploited in Brazil. Most of the production is based on extractivism in natural areas, without the implementation of an adequate management plan (Vilas Boas *et al.* 2021).

Mangaba is a fruit tree of the Apocynaceae family. This tropical species occurs naturally in coastal areas of Brazil's North and Northeast regions and is also found in different parts of the Cerrado biome (Soares *et al.* 2005; Lima; Scariot, 2010; Rabelo; Silva, 2015). According to data from IBGE (2023), the main mangaba-producing states in Brazil are Paraíba, with an annual production of 2,560 tons, followed by Rio Grande do Norte with 637 tons, and Sergipe with 350 tons. These figures highlight the economic and cultural importance of the mangaba in these regions.

Hancornia speciosa has great versatility of uses, making it an important resource for Brazil's bioeconomy. The conservation and sustainable use of this species are crucial, requiring special attention to the distribution and genetic diversity of its natural populations. This diversity is influenced by factors such as the degree of species evolution, its reproductive system, ecological and geographical aspects, and human interventions (Rao ;Hodgkin, 2002).

3.4 AGRONOMIC ASPECTS – CULTIVATION SYSTEMS

Mangaba (*Hancornia speciosa* Gomes) is a fruit tree native to Brazil with economic and cultural relevance, especially in the Northeast, where it is consumed by local communities and serves as an alternative source of income and subsistence (Silva *et al.* 2017; Morais *et al.* 2022). The species has high potential in various sectors and production chains (Oliveira ; Aloufa, 2020). In 2020, Brazil's national production of mangaba was estimated at 1,933 tons, with the state of Sergipe being the leading producer (Silva *et al.* 2017; Morais *et al.* 2022).



In addition to being rich in vitamin C, the fruit has antioxidant, antihypertensive, and antidiabetic properties (Almeida *et al.* 2022; Silva *et al.* 2017). The fruit is consumed when fully ripe, and the fruiting period varies by region, including the northeastern coast. There are two fruiting seasons: the winter season, from May to July or July to October, and the summer season, from January to April or December to April (Oliveira; Aloufa, 2020).

The species belongs to the Apocynaceae family and is in the early stages of domestication, being affected by genetic erosion and the anthropization of native biomes (Silva *et al.* 2022). The most widely accepted botanical classification recognizes six botanical varieties: *H. speciosa* var. *cuyabensis*, *H. speciosa* var. *gardneri*, *H. speciosa* var. *lundii*, *H. speciosa* var. *maximiliani*, *H. speciosa* var. *pubescens*, and *H. speciosa* var. *speciosa* (Morais *et al.* 2022).

However, this classification has recently been revised, and based on morphological traits, only two botanical varieties are now recognized: *H. speciosa* var. *pubescens*, which includes individuals with pubescent structures, and *H. speciosa* var. *speciosa*, which includes all other forms (Morais *et al.* 2022).

An allogamous and self-incompatible species, mangaba requires cross-pollination by different genotypes and specific pollinators to produce fruit. Pollination is performed by insects of the *Sphingidae* family (moths), which visit the flowers mainly at dusk (Costa *et al.*, 2015).

The species adapts to low-fertility soils and commonly grows in poor, acidic soils with low organic matter content (Costa *et al.* 2015). The mangaba tree can be found in four Brazilian biomes: Amazon, Cerrado, Caatinga, and Atlantic Forest. However, it occurs most frequently in the Cerrado biome, especially in slope areas with rocky soils, rocky outcrops, and in coastal plateaus and lowlands in northeastern Brazil (Morais *et al.* 2022).

Its berries have a pleasant aroma and high acidity and are appreciated for their organoleptic characteristics and high nutritional value, being rich in vitamins A, B1, B2, and C, as well as iron, phosphorus, calcium, and proteins (Tomazi *et al.* 2018). According to Silva *et al.* (2017), the Gardneri and Pubescens varieties predominantly produce round, light green fruits, and are noted for their potential in selection based on fruit size and weight. Meanwhile, the Speciosa and Cuyabensis varieties tend to produce oblong fruits with dark yellow and dark green coloring, respectively (Silva *et al.*, 2017). This species is not yet fully domesticated and, due to propagation by seed, presents significant variation among plants, even within the same population.



Studies on mangaba fruit characterization by Ferro *et al.* (2015) indicated high variability in fruit weight and size across all production environments, with most variation occurring between different populations. Coastal varieties tend to be larger and have an average pulp and peel yield of 80.4%. Additionally, the number of seeds was directly proportional to fruit weight (Ferro *et al.* 2015).

It is a species with high potential in various sectors and production chains such as agribusiness, latex production, and the extraction of pharmaceutical and nutritional substances (Almeida *et al.* 2016). According to Fonseca *et al.* (2018), despite its agribusiness potential, economic exploitation remains limited to unsustainable extractivist practices. It grows spontaneously, without rational or technical plantations, and the lack of fruit uniformity presents a challenge for industry, which requires standardized and high-quality fruit (Ferro *et al.* 2015).

Implementing conservation initiatives and breeding programs is crucial to ensure the preservation of native vegetation resources and the development of commercial cultivars, thus expanding production given the nutritional importance and therapeutic properties of the fruit (Silva *et al.* 2017; Morais *et al.* 2022). These conservation practices also promote artificial selection within populations, increasing the quality of managed resources (Oliveira; Aloufa, 2020).

Research efforts focus on improving cultivation techniques, including substrate composition for seedling production (Oliveira ; Aloufa, 2020). Although no commercial cultivars currently exist, germplasm collections have identified potential parent plants for breeding programs aimed at improving productivity and fruit quality (Morais *et al.* 2022). Conservation efforts are critical to preserving genetic resources and expanding production beyond local scales (Morais *et al.* 2022).

As populations are distributed across different biomes and environmental conditions, they represent a valuable opportunity to expand understanding of the species and identify its areas of occurrence. In this context, according to Silva *et al.* (2022), *in situ* conservation is essential for preserving the mangaba tree's germplasm, but implementation is challenging due to costs and the fact that most of these populations are located on private lands, making the creation of protected areas dependent on landowner cooperation and conflicting economic interests (Silva *et al.* 2022).



Thus, understanding the species' genetic diversity and propagation is necessary to assess the feasibility of establishing commercial orchards and implementing conservation policies. These should allow access to land and the use of resources while also considering the complex and evolving relationship with the people who manage and depend on the species (Oliveira ; Aloufa, 2020).

The processing of mangaba dates back to the 16th century, with Gabriel Soares de Sousa mentioning its use in sugar preserves by the colonizers in 1587. During the Dutch period in Brazil, mangaba preserves were offered as gifts, including barrels sent to Count Nassau (Mello, 1987). Over the centuries, the use of mangaba became established in traditional recipes for sweets, ice creams, and drinks, especially in Pernambuco. Historical records from the early 20th century highlight its use in chocolate bonbons and syrup-based sweets. In the 1930s, mangaba compotes began to be sold in cans, marking the beginning of a larger-scale production.

Institutional and experimental initiatives over the decades have promoted the use of mangaba, such as projects by Embrapa Cerrados, the Federal University of Goiás, and local organizations, which developed recipes like jellies, sweets, liqueurs, and gourmet products (Silva Junior *et al.* 2023).

The processing of mangaba pulp is the most important step in the production chain, as it is the basis for almost all fruit derivatives. Several studies and guides have been created to standardize and optimize processing stages, which begin with the selection of raw materials (Gonçalves *et al.* 2018).

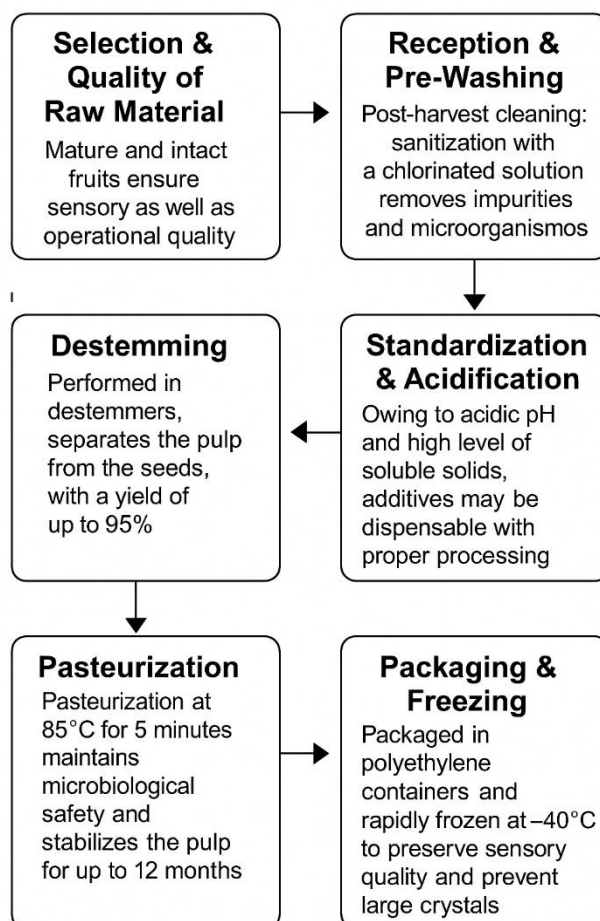
The production of mangaba pulp requires strict quality control of the fruit, prioritizing ripe ones that are free from dirt or contaminants. Green or overripe fruits should be discarded due to the high latex content, which affects sensory quality and machinery performance. To ensure the best quality, fruits should be hand-picked and allowed to ripen for 1 to 2 days in controlled conditions. After harvest, the fruits are pre-washed in running water or in specific tanks to remove dirt. They are then sanitized with a chlorine solution (100 mg/L) to eliminate microorganisms. Sanitized fruits are then sent for pulp extraction, which separates the pulp from the seeds. This process, performed in pulp extractors, should be adjusted to maximize yield, which can reach up to 95%. The pulp can be standardized according to legal standards. Although the legislation permits the addition of acidulants and preservatives, proper processing often eliminates the need for additives, as mangaba pulp naturally has an acidic pH and high soluble



solids content. After processing, the pulp is packaged in polyethylene containers and immediately frozen for preservation. Quick freezing at -40°C is ideal to prevent large crystal formation and maintain sensory quality. To extend shelf life, the pulp can be pasteurized in a water bath at 85°C for 5 minutes. After heating, the pulp is cooled in an ice bath.

This process ensures microbiological and sensory stability for up to 12 months. Frozen pulp should be stored at -18°C in freezers or specific chambers. During distribution and commercialization, maintaining the cold chain is essential to avoid temperature fluctuations that could compromise product quality.

Figure 1. Steps of mangaba pulp processing.



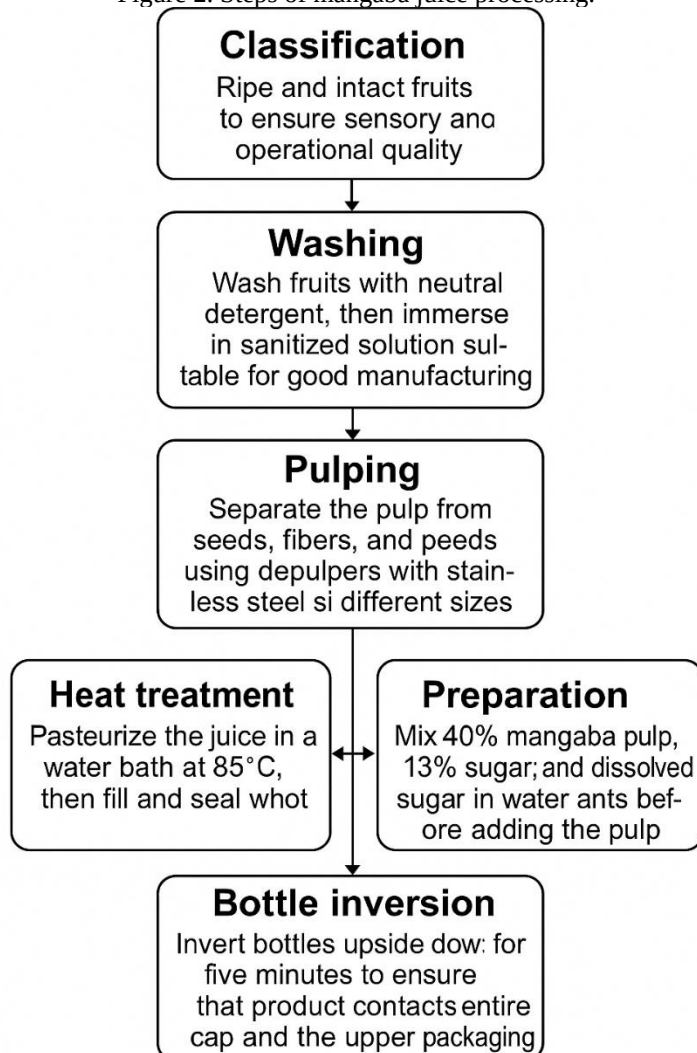
Source: Gonçalves *et al.* 2018.

Mangaba juice is one of the main derivatives of the fruit, and its production follows a process similar to the first three stages of pulp processing. The fourth stage involves the formulation of the juice. For each liter of juice, 40% mangaba pulp (400 g) and 13% sugar (130



g) are used. The sugar is dissolved in water before adding the pulp, forming the base. The juice is then pasteurized in a water bath until it reaches 85°C, followed by filling while still hot. The jars are inverted for 5 minutes to ensure sterilization of the lid and the top of the container. Finally, after pasteurization, the jars are cooled in an inverted water bath (cold) to prevent breakage and are then stored under refrigeration between 5 and 10°C, prolonging the shelf life for a few weeks. These stages aim to ensure microbiological safety, preserve sensory characteristics, and extend the durability of mangaba tropical juice (Neto *et al.* 2019).

Figure 2. Steps of mangaba juice processing.



Source: Neto *et al.*, 2019.

Many studies have been investigating how processing affects the quality of products derived from mangaba. The evaluations involve analyses of the physical-chemical profile of the



fruits and their byproducts, as well as sensory stability tests. The investigation of stability is particularly important to adjust processing methodologies related to pasteurization, cooling, and storage (Moura *et al.*, 2002). In a study with different formulations of mixed juices of mangaba and cagaita, the formulation with equal proportions of mangaba and cagaita (20%-20%) achieved the best acceptance and was submitted to stability tests. There was a tendency for sedimentation, especially after heating, although the presence of pectin minimized destabilization during heating times between 1 and 2.5 minutes. The results demonstrate the potential of mangaba for the development of processed products, highlighting its chemical versatility and sensory appeal (Martins *et al.*, 2017).

Zitha (2016) compared the chemical composition of mangaba jelly and sensory properties with fresh pulp, in addition to evaluating the impact of glass packaging (amber and transparent) and storage time (0 to 12 months). The jelly had higher levels of soluble solids, pH, pectin, carbohydrates, and energy value, while components such as water activity and titratable acidity were reduced compared to the pulp. Storage significantly influenced almost all variables except for ash, fiber, elasticity, and sensory attributes of color and aroma, while the type of packaging had no relevant impact. The jelly behaved as a shear-thinning fluid adjusted to the Herschel–Bulkley model.

Perfeito *et al.* (2016) evaluated two byproducts: clarified juice and nectar. Enzymes were used to increase the yield of mangaba juice, and the combination of hydrocolloids and thermal treatment was used to stabilize the nectar. The enzymatic process increased the release of clarified juice, but it developed a bitter taste. For the nectars, prolonged thermal treatment (95 °C for up to 60 minutes) increased the volume of sediments, especially in the control formulation without additives. The addition of 0.01% gelana gum ensured better physical stability of the nectar.

Mangaba fermentation has also been explored for various uses, such as the production of alcoholic beverages and vinegar, showing economic and functional potential. Almeida *et al.* (2020) developed four formulations, varying the initial soluble solids content and yeast concentration. Although the kinetic behavior of the process was not influenced by the variables, the formulations with higher soluble solids content showed better fermentative parameters, such as higher alcohol content and yield. A later study analyzed the impact of storage. During six months of storage, an increase in total and volatile acidity and a reduction in luminosity were



observed, with glass being the most effective packaging material for preservation. These characteristics reinforce the viability of using mangaba to produce fermented beverages with high added value (Almeida *et al.*, 2021).

In the development of mangaba vinegar, a semi-solid alcoholic fermentation process was used, combined with the enzymatic activity of pectinase. The final product showed high levels of volatile acidity, phenolic compounds, and total carotenoids, along with a 90% conversion yield of ethanol to acetic acid. Sensory analysis revealed a strong correlation between color and aroma, with good acceptance by consumers (Siqueira *et al.*, 2021).

In the mangaba production chain, there are many logistical and commercial challenges due to the need for cold chain preservation for products such as pulp and juice. As a viable alternative to extend shelf life and facilitate storage and transportation, drying processes have stood out, especially the foam-mat drying method (Figueirêdo *et al.*, 2014). This method presents advantages such as low equipment cost and operational simplicity, using temperatures below 100 °C. In a study on this method, mangaba pulp was treated with emulsifiers and thickeners, spread in thin layers of 0.3 cm, and subjected to drying at 50, 60, and 70 °C in a forced-air oven. The drying kinetics were modeled by three approaches (Page, Henderson & Pabis, and Cavalcanti Mata), which showed good fits to the experimental data.

Conegero *et al.* (2017) studied the stability of mangaba powder obtained by freeze-drying. After 90 days of storage at room temperature, the product was packaged in laminated and plastic bags, with and without vacuum, and analyzed periodically for ascorbic acid concentration, pH, water activity, and color. The laminated vacuum packaging proved to be superior in maintaining stability, preserving adequate levels of ascorbic acid according to daily consumption standards established by Brazilian legislation, and controlling water activity, a crucial factor for product preservation.

There are also studies investigating the potential use of mangaba in ice creams (Melo *et al.*, 2021), mixed jams (Silva *et al.*, 2021), cosmetics (Panontin, 2021), natural medicines (Almeida *et al.*, 2014; Pereira *et al.*, 2015), and flour (Vasconcelos *et al.*, 2023).



4 FINAL CONSIDERATIONS

The mangaba (*Hancornia speciosa*) presents great potential for commercial exploitation, being a fruit with high nutritional and sensory value, with wide versatility for both fresh consumption and the production of various derived products. Its production chain is mainly concentrated in the Northeast of Brazil, where the species finds ideal climate and soil conditions, but its adaptation to other regions of the country is also a viable possibility. The growing interest in mangaba, driven by both the domestic market and the potential for export of its products, highlights the importance of developing more efficient cultivation systems and processing technologies. For the mangabeira to establish itself as a sustainable commercial crop, it is essential to invest in research to optimize management practices, conservation, and processing, as well as to raise awareness of the nutritional and functional benefits of this fruit. The establishment of commercial mangaba plantations can represent an alternative source of income and economic development, especially for regions where production is still predominantly extractive. Therefore, in addition to exploring mangaba's potential as a market product, it is crucial to invest in studies that ensure the preservation of its native populations and promote the sustainable use of this species for the benefit of future generations.



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