Scientia Agraria Paranaensis – Sci. Agrar. Parana.
ISSN: 1983-1471 – Online
DOI: https://doi.org/10.18188/sap.v21i3.29602

MAIN PALM HEART-PRODUCING SPECIES CULTIVATED IN BRAZIL

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SAP 29602 Received: 09/03/22 Accepted: 19/07/22
Sci. Agrar. Parana., Marechal Cândido Rondon, v. 21, n. 3, jul./sep., p.216-229, 2022

ABSTRACT - Among the most targeted species for obtaining palm hearts, *Euterpe edulis*, popularly known as Juçara palm hearts, stands out and is threatened with extinction. The rational use of other palm trees for the production of palm hearts has been one of the alternatives to reduce the pressure of exploitation on the juçara palm: *Archontophoenix alexandrae*, *Bactris gasipaes*, *Euterpe oleracea*. This narrative literature review aims to discuss the four main palm tree species in Brazil. It is noted that despite the risk of extinction, there is still illegal and clandestine extraction of the *Euterpe edulis* species. The species of the same genus, *E. oleracea*, has significant cultivation in the northern region, but mainly due to the use of the fruit. *Archontophoenix alexandrae* is an exotic species that has adapted well to Brazil, and I offer a quality palm heart in the Brazilian market. The most cultivated species today is peach palm, it has advantages such as high tillering and shorter cultivation time.
Keywords: *Archontophoenix alexandrae* (F.Muell.) H.Wendl. & Drude, *Bactris gasipaes* Kunth, *Euterpe edulis* Mart., *Euterpe oleracea* Mart.

PRINCIPAIS ESPÉCIES PRODUTORAS DE PALMITO CULTIVADAS NO BRASIL

RESUMO - Dentre as espécies mais visadas para obtenção de palmito, destaca-se *Euterpe edulis*, conhecida popularmente como palmito juçara, e ameaçada de extinção. O uso racional de outras palmeiras para a produção de palmito tem sido uma das alternativas para diminuir a pressão de exploração sobre a palmeira juçara: *Archontophoenix alexandrae* (palmeira-real-da-austrália), *Bactris gasipaes* (pupunheira), *Euterpe oleracea* (açaizeiro). A presente revisão narrativa de literatura tem o intuito de discorrer a respeito das quatro principais espécies palmiteiras no Brasil. Nota-se que apesar do risco de extinção, ainda há extração ilegal e clandestina da espécie *Euterpe edulis.* A espécie do mesmo gênero, *E. oleracea* apresenta um cultivo significativo na região norte, mas principalmente em virtude da utilização do fruto. *Archontophoenix alexandrae* é uma espécie exótica, que se adaptou bem ao Brasil e oferece um palmito de qualidade no mercado brasileiro. A espécie mais cultivada atualmente é a pupunheira, tem vantagens como elevado perfilhamento e menor tempo de cultivo.
Palavras-chave: *Archontophoenix alexandrae* (F.Muell.) H.Wendl. & Drude, *Bactris gasipaes* Kunth, *Euterpe edulis* Mart., *Euterpe oleracea* Mart.

INTRODUCTION

Palm trees, as a representative of the Monocotyledons and the Arecaceae family, often compete with the Eudicotyledons for the forest canopy, and can reach, in forests such as the Atlantic Forest, a high value of importance, contributing with more than 20% of tree size individuals (ALVES et al., 2010). They are important for the maintenance of fauna and flora since they interact with other plant species and serve as food and shelter for animals (OLIVEIRA et al., 2010). Despite its ecological and economic importance, the palmitic flora is still poorly represented in Brazilian herbaria. At the same time, in many phytosociological studies, palm trees are neglected, sometimes due to the difficulty in collecting them, and sometimes due to the inclusion criteria adopted in the surveys.

In the case of Non-timber Forest Products (NTFPs), the botany family Arecaceae stands out (FERREIRA, 2011) and besides their high landscape value, palm trees have enormous economic value. According to Rufino and Employees (2008), the strips serve as a mainstay in rustic buildings; their leaves and fibers are used to cover housing, weave baskets, make brooms, hats, bags, sleep nets, fishing nets, etc.; the leaf in early days is consumed as palm heart; its floral bracts and raquillas are used as decorative objects; and its fruits and seeds have a large use, from culinary purposes to the production of jewelry and biodiesel. In addition, palm oils are widely used in the food, cosmetics, and medicines industries (OLIVEIRA; RIOS, 2014).

Palm's heart is an exquisite food with a thin taste, but still restricted consumption considered a typically Brazilian delicacy, is also admired, and consumed in several countries around the world that consider it an exotic product (SAMPAIO et al., 2007). The palm heart can be defined as the edible product, cylindrical, soft, and tender, extracted from the upper end of the stipe and leafy sheaths from certain palm trees, corresponding to the apical meristem, completely wrapped by undeveloped leaves, and positioned at the end Higher Stipe (MODOLO et al., 2007; CEMBRANELI et al., 2009). Also second to RDC No. 17 of November 19, 1999, published by the National Health Surveillance Agency - ANVISA (BRAZIL, 1999), recognizes as the edible portion of the own palm tree for the

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apical gem and the above and regions consumption and regions Below this, which corresponds to the soft leaves (heterogeneous structures), and the soft tissues of the stipe (homogeneous structures).

According to Frasson and Lopes (2002), in Brazil, the economic use of the palm heart began in the South and Southeast regions in the 1930s. At this time, all the production of palm heart came from the extraction of the Juçara palm tree, *Euterpe edulis* Mart., being the main non-tapped product of the ombrophilous dense forest and was almost extinct from its natural habitat (FANTINI et al., 2000). Currently, the palm tree *E. edulis*, previously found in abundance, has become scarce in the Atlantic Forest from all over Brazil, however, its palm heart is still largely marketed.

Juçara palm tree is extremely targeted for illegal extraction from forests for its commercialization. This fact makes it scarce in its places of origin and its large-scale exploration, especially due to the production of canned palm hearts. Thus, there is an evolutionary picture of a drastic reduction of its population, in addition to the deforestation of the forest for illegal occupation (MARTINS et al., 2009). Several factors contributed to the Juçara palm tree to enter endangered. One of these factors was his intense exploitation, due to the simplicity that the explorers found to extract it. The fact that the Juçara palm tree has a long production cycle is another factor that contributed to its scarcity. According to Souza and Lima (2019), due to disordered exploitation, the natural regeneration of this species no longer met the demand for raw materials of companies. For these reasons, interest in species that may be an alternative for canning palm heart production has been growing, thus decreasing the impact on the Juçara palm tree.

Brazil has several palm tree species that produce edible palm hearts, dominating the scene with the production of approximately 95% of palm hearts (RIBEIRO et al., 2011). The most important native species in palm heart extractivism are *Bactris gasipaes* Kunth and *Euterpe oleracea* Mar.. According to Torres et al. (2005), it was already expected to have the introduction of several species in the market since is no longer allowed to the extraction of palm hearts from palm trees in the forest, there is a replacement for palm heart cultivation for sustainable management projects, for agronomic and environmentally friendly bases correct.

The intense pressure on the Juçara palm trees forced some palm companies to look for similar raw material, such as Acai Palm - *Euterpe oleracea* (REIS et al., 2003), which is a tropical, perennial palm tree, native to the eastern Amazon. Acai has the profile, but the cut break is 4 years (IAC, 1998), which at the peach palm, after the first cut, can occur annually.

Among the many palm heart-producing species, two others stand out for having the greatest number of advantages for cultivation, namely the peach palm and the Australian royal palm. The cultivations of these two palm trees have, as one of the main advantages over the cultivation of Juçara and Açaí, precocity (SOUZA; LIMA, 2019). Both the first cut of the peach palm and the Australian royal palm can be done, on average, at 3 years of age after planting, depending on the growing conditions. A viable alternative is the cultivation of peach palms, which occurs naturally in northern Brazil. The peach palm is a palm tree originally from the Amazon region, being domesticated and disseminated in this region and Central America by indigenous peoples. It is a great alternative for palm heart production, which can be explored in organized plantations, and has desirable characteristics, such as precocity, tillering, yield, and quality of the palm heart (CHAIMSOHN, 2000).

In the mid-1990s, the Australian royal palm appears as another alternative to palm heart production. The genus *Archontophoenix* originates from the west coast of Australia and is used all over the world for ornamental purposes and, lately, has been standing out as an excellent producer of palm heart (UZZO et al., 2004). This palm has adapted well to the environmental conditions in Brazil, in addition to having potential qualities such as precocity, rusticity, and the taste of its palm heart (FRASSON; LOPES, 2002).

It is important to point out that the cultivation of peach palm and the Australian royal palm reduces the impact caused on the natural populations of Açaí and Juçara since almost all the palm heart coming from these palm trees comes from extractivism, which is often not implemented in the form of sustainable management (ABRAPALMER, 2017). In these sustainable plantations, palm hearts can be standardized, obtaining better quality due to greater control of the entire process, from the choice of seeds to the industrialization of the palm heart. As for the sanitary issue, there are minimum quality characteristics that must be obeyed and applied so that there is the production of the canned palm heart, for this purpose, the fibrous parts are removed by peeling and cutting, to be immersed in water, spices, and other ingredients, and subsequently acidified and heat-pasteurized in an appropriate manner. The intention of a correct treatment in the production of palm heart is that it is free of viable forms of microorganisms that can reproduce in the food after it is stored and hermetically packed, that is, guaranteeing the sterility of the product (BRASIL, 1999).

The palm heart has been used in Brazilian food since ancient times, at first by indigenous people and later by Portuguese and enslaved colonizers. The history of Brazilian forest-based economic activity reflects the predominance of extractivism throughout its 500 years of history. In the palm heart production segment, during the last four decades, there has been intensive exploitation of *Euterpe edulis*, reaching, at the beginning of the 21st century, the point of total exhaustion of the natural populations of this species: the low stocks do not allow the continuity of its unrestricted commercial exploitation. The economic exploitation of palm heart is recent since until the beginning of the 1990s the activity was predominantly extractive and not very organized. From this period, however, palm heart agribusiness became a relevant activity with high potential in terms of production and economics.

To meet the national demand, the sector increased the cultivation of native and exotic species, regulated by environmental and quality control standards.

Given the above and in the current context, the study and inclusion of palm tree species are essential to maintain the supply of palm hearts on the market, as well as to protect the Juçara palm tree. This narrative literature review aims to discuss the four main palm tree species in Brazil: *Euterpe edulis* Mart., *Archontophoenix alexandrae* (F.Muell.) H.Wendl. & Drude, *Bactris gasipaes* Kunth and *Euterpe oleracea* Mart.

DEVELOPMENT

Arecaceae Family

Since the first taxonomic treatment was given to palm trees in 1753 by Linnaeus, who called them 'Principes' – the princess of plants, they are recognized as a natural and isolated group, composed of an order (Arecales = Princes) and a family (Arecaceae = Palmae). According to Uhl and Dransfield (1987), the Arecaceae family has six subfamilies, and five of them occur in Brazil, with 10 genera and 40 species, in the Atlantic forest. In the list of species of flora in Brazil, 39 genera, 269 species, and 41 varieties are accepted, of which four genera, 113 species and one variety are endemic (LEITMAN et al., 2013).

After the first botanical collections made in the Caribbean by the Austrian Nicholaus Joseph Jacquin, the great contribution to the knowledge of palm trees in the Americas came with the arrival of the expedition (1817-1821) of naturalists, coordinated by Carl Friedrich Philipp von Martius (BALICK, 1988). Martius had a special fondness for palm trees. His work Historia Naturalis Palmarum: opus tripartitum, published between 1823 and 1850, contains contributions from him and other specialists and, in the third volume, descriptions of all the palm trees known until then (SHEPHERD, 2006). In the most ambitious project carried out on the Brazilian flora, Flora brasiliensis, Martius' studies on palm trees were gathered by Oscar Drude and published in Munich, in 1882, as "Palmae". Other 19th-century botanists who contributed to the knowledge of the palmitic flora were: Anders Oersted, Hermann Wendland, Alfred Russel Wallace (published in 1853 Palm trees of the Amazon and their uses), the first book on palm trees with ethnobotanical treatment (KNAPP et al., 2002).

The Arecaceae family is composed of 3,000 species of palm trees and in Brazil, it represents about 390 species, most of which are native to the Amazon, where about 41 genera and 290 species are recognized. Of these 41 genera, the genera *Euterpe*, *Bactris*, *Astrocaryum*, *Oenocarpus* and *Jessenia* stand out regionally, nationally and internationally, which total 20 potentially economical species for the agribusiness of fruits, palm heart and edible oil, and more recently, as an alternative for the biodiesel production (OLIVEIRA; RIOS, 2014).

The palm trees represent the third most important botanical family for humans: they have a wide distribution, abundance, productivity, and diversity of uses, and are of great food, medicinal, socio-cultural, and economic importance for local populations (SOARES et al. 2014). Palm trees, in addition to being ornamental plants, have almost full use potential. Besides the palm heart, palm leaves are used in animal feed, wood, and fibers in the manufacture of houses, boats, baskets, hats, clothes, rope, and paper. Oil, olive oil, honey, liquor, juices, ice cream, wine, and sugar can be obtained from its fruits.

Many palm trees can present variations in morphological characters according to the environment in which they occur, making it difficult to understand the taxonomic entity to which they belong. These authors consider that 10% of the palm trees in the Americas are "complex", which means, widely distributed and variable, containing several more or less distinct forms, joining each other in intermediate forms. Usually, in the same area, more than one form can occur together, whose morphology is also different. In addition to complex species, Henderson (2006) pointed out that palm tree systematics also face problems with subspecific variations, hybrids and hybrid zones, and biogeographical patterns. Since the 1990s, research that seeks to contribute to the understanding of the systematics and phylogenetic relationships of the family, combining information from morphological analyses, chloroplast DNA, and nuclear DNA, has already allowed a range of palm subfamilies to have their phylogeny well-resolved (RONCAL et al., 2012). The collection difficulty is largely due to the size of the vegetative and reproductive organs. Some leaves reach 8 m in length and 20 kg or more of fresh weight and some inflorescences have up to 30 kg (BALICK, 1988). In addition to these difficulties, there are problems in herbaria, involving aspects related to herborization, such as drying and packaging of material (DRANSFIELD, 1986).

The family has the following characteristics: stipe is generally woody, simple, or branched, most of its species have thorns, its leaves are petiolate, simple, alternate or rarely distichous, palmate or leaf segments (ALMEIDA, 2018). It is noticed that the systematics of the family is traditionally based on the morphological characteristics of the stems, leaves, fruits, and flowers, on the anatomical particularities of its organs, on the comparison of cytological and histological characteristics, studies of current geographic distributions and history of the family and genera evolution (SOARES et al., 2014).

According to Broschat (2013), palm trees differ greatly from trees (eudicots and gymnosperms) in their general shape and external structure (morphology) and in their internal structure (anatomy) (Figure 1). Palm stems are characterized by having a single apical meristem or growing point, all new leaves and flowers develop from the apical meristem, which is surrounded by the bases of the leaves. The area of the palm tree where the leaves are located is called the crown or crown. Palm leaves are generally of two types: Pinnate or plumose leaves have leaflets completely separated from each other and are attached perpendicularly to the rachis, extension of the petiole on the leaf blade; Palmate leaves with adjacent leaflets or leaf segments are joined laterally for part or most of their length. Palm fruits are botanically classified as drupes and have one or more

seeds covered by a fleshy, chalky, or fibrous mesocarp and a thin superficial epicarp (BROSCHAT, 2013).

The development in the stem is a result of parenchyma cell enlargement or lignin deposition. This growth results in a unique allometric pattern, where height can increase almost unlimitedly by plant diameter when compared to other species. The surface can be smooth to extremely rough and gnarled and can be armed with sharp spikes. Some species display prominent and often attractive leaf scars on their stems, which were spots where the leaves were attached to the stem. The spacing between these leaf scars (internodes) is a function of the stem growth rate. Once a juvenile palm stem reaches its maximum diameter, substantial vertical elongation of the stem begins and the increase in stem diameter essentially ceases. Death of the apical meristem in a palm result in the death of the stem in clustered species and the death of the entire palm in single-stemmed species.

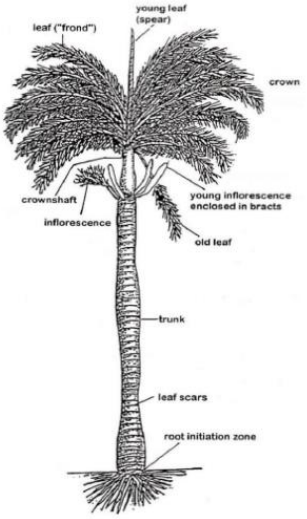

FIGURE 1 - Generalized morphology of a palm tree. Source: Broschat (2013).

Palm trees are typical exponents of tropical plants and play an important role in natural and human communities, in addition to these benefits they popularly stand out as a host for many epiphytes. They have impressive development and great ecological importance, mainly as food resources. After their fruits are dispersed and their seeds land in the soil, development should begin quickly because most of them do not form seed banks in the soil (HENDERSON et al., 1995). In neotropical regions, the importance of palm trees is confirmed in several ethnobotanical studies, concerning food, medicine, or socioeconomic aspects.

Despite the Arecaceae family having an important role in the ecosystem, as a habitat for animals, a source of employment for local and regional communities, and the supply of food for animals and humans, it is a little-explored family about other botanical families. They stand out in different resources, used as ornamental, mainly due to their size and foliage, being widely used in streets, squares, establishments, and residences, mainly beach houses and riverside communities, and several other uses. The economic value of the family has aroused interest in management since its species prove to be resistant to deforestation and burning (MIRANDA et al., 2001). The products provided by palm trees are of great relevance, raw material for making handicrafts, construction, and household utensils, in addition to fruits, which contain high nutritional value (NASCIMENTO, 2010).

Potential species for palm heart production: Genus *Euterpe*

The genus *Euterpe* can be found in the Cerrado, Atlantic Forest, and Amazon biomes (LEITMAN et al., 2013). In Brazil, the species *Euterpe edulis*, *Euterpe oleracea*, and *Euterpe precatoria* Mart. have been exploited for human consumption, for the production of Açaí from the fruits or extraction of palm heart. Among many examples from Brazil, two palm trees are cultivated: *Euterpe oleracea* and *E. edulis* (Figure 2). The fruits of both species are important in terms of food resources for birds in their original areas (GENINI et al., 2009). In Brazil, the genus *Euterpe* consists of five species, with four infraspecific epithets, without subspecies, and four varieties. All species are terrestrial and arboreal. They are native to Brazil, but not endemic, occurring in anthropized areas and forests.

FIGURE 2 - *Euterpe oleracea* x *Euterpe edulis*. Source: Furlaneto et al. (2020).

Euterpe edulis (popularly known as Juçara) is a palm tree found in the Atlantic Forest region, disseminated mainly in the states of Rio Grande do Sul, Santa Catarina, Paraná, São Paulo, Rio de Janeiro, Minas Gerais and Bahia (Figure 3), in these regions are commonly used as food (CUNHA JUNIOR et al., 2015). The Juçara palm serves as food, providing its fruits to fauna and man, as well as the palm heart, which was first used by the indigenous people (FIGUEREDO et al., 2015). *E. edulis* has the important characteristic of being a single-stemmed palm, therefore it does not generate tillers (LORENZI et al., 2004), which proves that the extraction of the palm heart leads to the death of the plant, being a species that takes six to nine years to produce seeds, making this plant species an ecologically relevant fact.

The palm is 15m high on average, with a stipe 15 cm in diameter at breast height, and at the apex it has a group of pinnate leaves 2.0 to 2.5 m long, each leaf having 45 to 72 pairs of pinnae, divided along the rachis (SOARES et al., 2014). At the base of the stipe, it has a brown to red root cone. On average, three inflorescences are produced by the palm tree, which are divided intrafoliate and to the point of the first rule (SOARES et al., 2014). The inflorescences contain rachis 70 cm long, with a rachilla full of triad flowers, two male and one female flower. The palm tree produces many fruits, and in good conditions, a plant produces the equivalent of 8,000 to 10,000 seeds (RAUPP et al., 2009), and it should be noted that 1 kg of seed corresponds to about 750 units (LORENZI et al., 2004). The Juçara palm tree produces fruits that are round drupes of black-violet color, with a single rounded and light brown seed (PEREIRA et al., 2012).

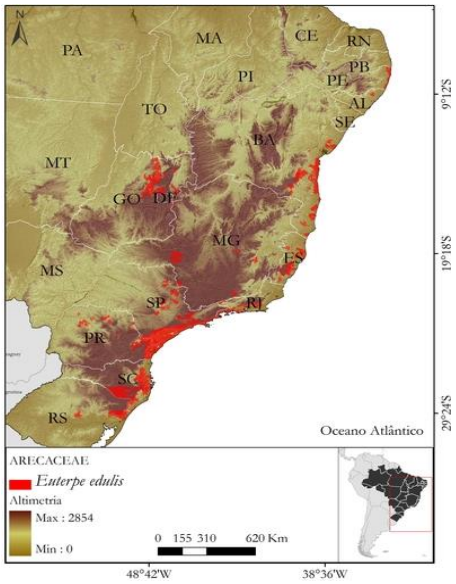

FIGURE 3 - Distribution of *Euterpe edulis.* Source: CNFLORA, 2013.

Its composition presents a diversity of phenolic constituents that help prevent degenerative diseases and, due to its antioxidant potential, contribute to health promotion (BICUDO et al., 2014). It became one of the top ten "superfoods" in 2012 due to this functional property (SMITH, 2013). With the proof of its benefit in combating inflammatory and oxidative mediators, it still stood out in the cosmetic and nutraceutical areas (CUNHA JUNIOR et

al., 2015). In addition to its fruit, Juçara is also known for the production of palm heart, stimulating international interest due to its high quality, presence of beneficial constituents, as well as its excellent flavor, and different from the other *Euterpe* species that also have economic notoriety in Brazil (BORGES et al., 2013).

After cutting to extract the palm heart, there is no regrowth due to the elimination of the apical bud, causing a major problem for the preservation and maintenance of the species, which is why its exploitation and export caused great concerns (YAMAGUCHI et al., 2015). Therefore, Euterpe edulis is present in the Normative Instruction of the Ministry of the Environment nº 6, of September 23, 2008, due to indiscriminate extractivism, belonging to one of the endangered species of Brazilian flora (BRASIL, 2008). In the state of Paraná, the Juçara palm heart is produced in an extractive system, and currently, it can only be marketed with the approval of a strict management plan, which led to a drastic reduction in production (PARANÁ, 2013).

Euterpe oleracea (Açaí palm), is medium-sized, reaching 10 to 15 meters in height, multi-stemmed with the capacity to emit up to 18 tillers with the diameter of the main stipe ranging from 15 cm to 20 cm, being slightly curved (VILLACHICA et al., 1996). The leaves are compound, pinnate, and with an almost erect insertion, reaching up to 5 m to 7 m in length, in addition to having thorns of varying sizes on the rachis, leaf sheath, and on the edges and main vein of the pinnae (HERDERSON, 1995). The açaí tree originates in Central and South America (Figure 4), and it is considered the most productive palm tree in the Amazon region.

Recently, much attention has been paid to its antioxidant capacity and its possible role as a functional food or food ingredient. In recent years, the açaí fruit has gained international attention as its phytochemical composition (BONOMO et al., 2014). It is a tropical species with fruits grouped in clusters, it has a globose shape, 1 to 2 cm in diameter, and an average weight of 1.5 grams, the epicarp is purple. Its export to other non-tropical countries, mainly to be used in fruit juices, has increased over the years. It stands out for being a fruit that is consumed as a staple food in this region of Brazil.

E. oleracea produces several stems and its apical meristem is also exploited for the production of palm heart (LORENZI et al., 2010) which are harvested for the production of açaí cream. Palm heart from *E. oleracea* is inferior in quality to its congener, but with multiple stems, production can be higher and the plant is not necessarily killed during palm heart extraction. The quality of its palm heart, the growing demand from the consumer market, and the scarcity of *E. edulis* made it one of the most expensive palm hearts in Brazil.

According to data from the Brazilian Institute of Geography and Statistics (IBGE, 2017), the national production of açaí was 219,885 tons, a volume 2.0% higher than that recorded in the previous period. The *Euterpe* species were highly threatened, mainly *E. oleracea*, until the 1970s, due to disorderly extractions. Currently, with the strong importance of fruit production, it is believed that this scenario has changed. However, there is still concern about the inadequate management practiced in some populations to increase productivity. Brazil is the largest holder of germplasm of the *genus Euterpe*, with conservation records in banks and collections in several research institutions (OLIVEIRA et al., 2019).

FIGURE 4 - Distribution of *Euterpe oleracea.* Source: Yamaguchi et al. (2015).

Potential species for palm heart production: *Bactris gasipaes*

The genus *Bactris* has a wide distribution in the New World and is composed mainly of small and medium-sized plants, almost all of which have multiple stems, that is, resulting from sympodial branching. Stem size ranges from as narrow as 5 mm in diameter to 25 cm (Figure 5). As explained by Henderson (2011), *Bactris* is notoriously difficult to study because most species are spiny, including even flowers and fruits, so they tend to be avoided. For this reason, the species is rarely cultivated. The most obvious exception is *B. gasipaes* (peach palm), a species with

several thornless varieties, widely cultivated for its fruits, which have a rich fleshy mesocarp, and for extraction of palm heart.

Bactris gasipaes is a palm in which all parts of the plant are used, although they are the most important, with great market potential (CLEMENT; MORA URPÍ, 1987). Pleasant and tender in flavor, fresh palm hearts can be eaten fresh or cooked in water with lemon and salt, or even baked in the oven and preserved (KERR et al., 1997). It is soft, nutritious, and has low caloric content, in addition, it is rich in fiber, minerals, and amino acids important for human nutrition (RESENDE et al., 2009).

FIGURE 5 - Distribution and morphology of *Bactirs gasipaes.* Source: CNFLORA, 2013.

Another striking characteristic of peach palm is its ecological character, the palm can be cultivated in agricultural areas, pastures, or capoeira, without damage to native forests, enabling reforestation and agro-industry planning, with palm heart production programming (NISHIKAWA et al., 1998). In addition to becoming the consumption preference that previously belonged to the açaí palm heart, the production of peach palm heart has also been occupying space in the market dominated by the palm heart from the Juçara palm. In Brazil, the peach palm cultivation area has grown a lot, mainly due to the tillering of the plant. As already mentioned, this is one of the characteristics most desired by palm heart producers, since, in addition to eliminating new plantings for a long time, it increases palm heart production, thus diluting the costs of implanting the crop and offering the possibility of frequent cuts, a fact that provides constant income to the producer (PENTEADO JUNIOR et al., 2010).

The peach palm presents itself as a sustainable alternative for the production of palm heart. The first harvest can be done two years after planting, while the production of other palm trees of the Euterpe genus begins between the sixth and eighth year of age. Despite the increase in the area planted with peach palm, the palm heart production of this species is still insufficient. There is a significant consumer market for palm heart in general, with an average quantity of 9.0 thousand tons per year and an income of around US$ 3.6 per kilo of the product, industrialized and sold wholesale. Just to serve the domestic market, 130,000 hectares would be cultivated with peach palm (RESENDE et al., 2009), with the states of São Paulo and Bahia being the largest producers, with more than 5,000 ha each.

Peach palm has become a great alternative to palm heart production as it has numerous qualities such as precocity and use of the tender part of the stipe; quality, palm heart does not oxidize and can be marketed fresh; its cultivation decreases the extraction of palm heart from native palm trees (ABRAPALMER, 2017). In addition to palm heart, the peach palm has several other uses, such as direct consumption of its fruits, flour for baking, and for animal feed, however, palm heart is today the most important economic product obtained from the peach palm (IAC, 1998). However, peach palm cultivation has some limitations, such as difficulty in acquiring and high price of seeds and seedlings, due to its fasciculated and superficial root system, it does not tolerate drought, it does not support soggy soils, its palm heart has a sweeter flavor and, after canned processing, it becomes yellowish (CHAIMSOHN, 2000).

In Brazil, peach palm cultivation for palm heart production should be established in areas with average annual precipitation greater than 2,000 mm, well distributed throughout the year, with an average annual temperature of around 21°C and relative humidity between 80% and 90%. It should also be noted that the peach palm does not tolerate frost (NEVES et al., 2007). Peach palm showed better development in regions with a hot and humid climate, soils of medium and sandy texture, with good drainage and adequate levels of nutrients and organic matter (IAC, 1998). Propagation can be done by seeds that, for the most part, come from the Amazon and Peru, with one kilogram of seeds corresponding to an average of 400 seeds, allowing for an approximate production of 200 seedlings (CHAIMSOHN, 2000). The Campinas Agronomic Institute (IAC, 1998) recommends the following spacing: 2.5 x 1.0 m, 2.0 x 1.0 m, 1.5 x 1.0 m, or 2.0 x 1.0 x 1.0 m (double lines). Fertilization at planting and fertilization at production must be applied. In the first year, the peach palm can be intercropped with other species of green manures of erect size or crops, between the planting lines, which is

recommended in areas subject to drought and strong winds (CHAIMSOHN, 2000).

Harvest should take place between 18 and 36 months after planting, depending on the soil, climate, spacing, and fertilization. It is not advisable to harvest at ages older than three years, as excessive growth in diameter will cause problems in filling and make standardization difficult, the quality of the palm heart may be impaired due to the increase in the proportion of fibers, the return on investment takes longer and the growth of the tillers and the cutting of their palm hearts is retarded. The harvest should be staggered based on the diameter of the plant, which should have, at 50 cm in height, from 10 to 14 cm in diameter. The palm heart can be cut throughout the year, however, cutting in the dry season should be avoided, due to its lower weight. The cut should be made 50 to 80 cm from the ground, to recycle the nutrients to the tillers in the clump and take care not to injure them (IAC, 1998; CHAIMSOHN, 2000). The variations observed in the economy of palm heart production may be associated with different factors, such as implementation and management costs, productivity, which is related to edaphoclimatic conditions, as well as the marketed value.

Potential species for palm heart production: *Archontophoenix alexandrae*

The genus has two species suitable for commercial planting in Brazil, these being *Archontophoenix alexandrae* and *Archontophoenix cunninghamiana* H. Wendl. & Drude. Both are palm trees, native to the west coast of Australia (KALIL FILHO; RESENDE, 2001). Among the various palm trees, the Australian Royal Palm - *Archontophoenix alexandrae* deserves special attention, mainly due to its characteristics of precocity and rusticity (Figure 6). At first, they were cultivated as ornamental plants, currently standing out as palm heart-producing species, providing technical and economic advantages in their cultivation. Its palm heart deserves attention, as it is considered a noble type, with a standard of quality and flavor, although it also darkens quickly after cutting (UZZO et al., 2002). The species *A. alexandrae* adapts better in regions with a typically tropical climate with altitudes below 1,000 m, while the species *A. cunninghamiana* adapts better in regions with a subtropical climate with altitudes above 1,000 m. The species *A. cunninghamiana* usually has lower productivity than *A. alexandrae* (FRASSON; LOPES, 2002). According to Bovi (2011) the species easily adapts to flat or undulating areas and different types of soil.

The part of the stem of the Australian Royal Palm that supplies the palm heart is made up of three sheaths: the outer, middle, and heart of the palm. The outer sheath that surrounds the palm heart is fibrous and its function is to protect the leaves that are in formation. They are greenish or brown in color and are not used in the industrialization of palm heart and represent 25 to 35% of their dry weight, depending on the species of palm. The second lighter-colored sheath, which presents 25 to 30%, is the median or semi-fibrous sheath. This layer is used to protect the palm heart during transport to industrialization and is also not used, being discarded at the beginning of processing. Finally, there is the crumb, which contains low fiber content. This part produces the canned palm heart (RAUPP et al., 2009).

Archontophoenix alexandrae represents an important agroecological alternative for plant diversification and generation of a source of income for production systems in different regions of the country, as it generates good quality palm hearts in the short term, based on the search for native plants. Its fast growth, resistance to several diseases, adaptation to different types of soils, and the quality of the palm heart generated boosted the expansion of this crop (UZZO et al, 2004). Palm trees have also been threatened by the establishment of pastures and other agricultural activities, as well as by population growth and real estate expansion (OLIVEIRA; RIOS, 2014).

The interest in this palm tree as a palm heart producer began in the 1990s, when the predatory exploitation of the Juçara palm in southeastern Brazil and the Açaí palm in the north had reached its peak and native palm heart reserves were already quite dilapidated. The market has been gaining space in this region, mainly in the state of Santa Catarina State, which is the cultivation of Australian Royal Palm for the production of canned palm heart (RODRIGUES; DURIGAN, 2008).

FIGURE 6 - Morphology of *Archontophoenix alexandrae*. Source: Globeplants (2022).

The production of palm hearts in species of the genus *Archontophoenix* is carried out after two years in the field, as long as they are cultivated in suitable regions and with fertilization (BOVI, 2011). The number of plants per

hectare may vary from 10,000, in places with low productive potential, to 20,000 plants per hectare where the productive potential is high (ABRAPALMER, 2017). Planting should be done during the rainy season, avoiding the hottest and driest periods. A phosphorus-based planting fertilization should be carried out, since most Brazilian soils are deficient in this nutrient, with recommendations for amounts of 400-500 kg of simple superphosphate/ha, which should be incorporated into the soil in the pit (FRASSON; LOPES, 2002). The topdressing fertilization should be divided 3 times a year, to provide nitrogen and potassium, the amounts of which should be calculated after a chemical analysis of the soil (ABRAPALMER, 2017). For the cultivation of the *A. alexandrae* and *A. cunninghamiana* species, association with other crops can be made, preferably using short-cycle commercial plants (for example, corn and sunflower) or green manure species (dwarf pigeon pea or jack beans, for example). Harvesting should be done when the plant reaches 2 m in height, with a stem diameter of 50 cm from the ground, 12 to 14 cm, which should happen around 3 years of age (FRASSON; LOPES, 2002).

The high productivity of the Australian Royal Palm, however, leads to the generation of a large amount of vegetable residue from processing. Thus, valuing the waste generated is an attractive alternative to generate business development in the sector, in line with sustainability concepts, such as principles of non-waste generation (MCDONOUGH; BRAUNGART, 2002). Therefore, the canned palm heart process generates an amount of waste that is deposited at the harvesting site, and among the works proposed for the recovery of the residue are: the application of palm sheaths for the production of hydrolytic enzymes by fungi of the genus *Polyporus* (ISRAEL, 2005) used in food and beverage industries, as well as in textile and cleaning product industries; obtaining food products such as fibrous biscuits (VIEIRA, 2006); or as substrates in the cultivation of fungi of the species *Pycnoporus sanguineus* (BORDERES, 2006) and *Lentinula edodes*, which are used for edible purposes, bioremediation or effluent treatment.

Palm heart market, certification, and production process

Since the beginning of its activities in Brazil in 1949, the palm heart agroindustry has undergone several transformations until the present time. At first, it was an extractive culture, having the Juçara palm as the primary variety of palm for its products. After a few decades after the beginning of the activities of the then-recent palm heart agroindustry, specifically between 1970 and 1974, there was a massive closure of industries in the sector in the southeastern region of the country, with many of these companies reopening in the state of Pará due to availability of other palm species. This movement of industries is due to the scarcity of raw materials in the Atlantic Forest region, due to the extraction without technical handling of palm trees and rampant deforestation for logging and opening of areas for the agricultural sector (RODRIGUES; DURIGAN, 2008).

With the establishment of most companies in the north of the country, the açaí palm tree, of Amazonian origin, began to be used for the production of canned palm heart and became, until the mid-90s, the main palm heart consumed in the market. , setting the mark of 90% of palm hearts sold (MORO, 2014). According to Tonet et al. (1999), during the 1990s, the domestic market consumed 90% of national production, with the remaining 10% destined for the international market. With the significant and increasingly growing domestic demand for palm heart, even açaí trees that did not reach the ideal size were harvested, significantly reducing the number of plants present in the Amazon region, a scene that was repeating itself as it had happened with the Juçara palm heart. For this reason, farmers and specialists were looking for other palm trees that could produce palm hearts ecologically and sustainably, on an industrial scale to meet market demand, the best-known plant being the peach palm (MORO, 2014).

Before the 1960s, the basic production of palm heart came mainly from the southern coast of the country, being extracted from the Juçara palm tree (OLIVEIRA; RIOS, 2014), where the State of São Paulo was then the main producer. The pace of exploitation, without corresponding replanting, led to a rapid drop in the number of native palm trees in this region. This scarcity of raw materials led to the shift of the largest palm heart processing companies to reserves of açaí trees (BOVI, 2011). Its consumption increased during the expansion of coffee cultivation, which took place in the South and Southeast of the country, where the Juçara palm tree was used to build homes for settlers using the stem for walls and floors, the straw (leaf) for covering the houses and palm hearts as food (YUYAMA, 2005).

As an alternative to the selective exploitation of Juçara, species such as peach palm and royal palm from Australia were introduced and cultivated in southern Brazil. However, palm hearts from palm trees such as Juçara, Açaí, and the Australian royal palm have high levels of oxidative enzymes, which depreciate the quality of the product by producing browning, both in canned palm hearts (when improperly processed) and, mainly, in fresh ones (SOARES, 2014) and, therefore, such processing requires the use of antioxidant additives to inhibit such effects.

In modern agroindustry, after removing and discarding the sheaths, the noble part of the stems called the stalk, is bottled in brine, and destined for sale, according to the quality standard classification and according to the purpose. This part is located in the portion that has the largest diameter and offers two pieces of better quality, which have characteristics of lower density, and more tender. These billets are more valued and provide a higher sale price. The remaining pieces, considered less noble, are packaged in slices, or chopped and sold at lower prices. The raw palm heart, protected by harder husks, is received at the industries where it undergoes the first stripping process. In this operation, 2 to 3 sheaths are removed, which protect the core of the palm heart during transport from the field to the yard. In the next step, the palm heart is transported to the interior of the factory, where the second peeling is carried

out, removing the remaining sheaths that surround the palm heart to be bottled (SUFRAMA, 2003). In most producing regions in Brazil, the sale of stems between producers and the agroindustry is conducted directly, where the products are traded fresh, a few hours after being harvested. The stalks arrive at the agroindustry with two sheaths or covers, which protect the palm heart. On average, the stems are around 70 cm long. In the industrialization process, palm hearts are classified according to diameter, shape, and length.

Brazil stands out in terms of the industrialization of canned and pasteurized palm hearts both for the quantity processed and for its research in this area. Canned palm hearts can be contaminated by microorganisms from the soil, surface water, and, mainly, through fecal matter. Products such as palm heart are subject to the development of *Clostridium botulinum* when an efficient heat treatment procedure is not applied to obtain commercial sterilization and also when the pH of the food remains above 4.5. This bacterium is capable of producing a toxin that, when ingested by humans, causes a syndrome known as botulism. *C. botulinum* spores can be carried into the bottled product from the soil and by the palm heart stalk (RAUPP, 2001). *C. botulinum*, when preserved in palm heart bottled under the conditions mentioned above, can produce a toxin that, if ingested by humans, causes a syndrome known as botulism, which, not infrequently, can result in death for the consumer who ingested it. this food product (RAUPP, 2004).

Raupp (2004) presents as one of the factors responsible for the approximately 90% decrease in Brazilian palm heart exports the wide dissemination by the Brazilian media in the late 1990s of some cases of botulism linked to direct consumption of canned palm heart. This caused concern and insecurity in the market regarding the consumption of the product, in addition to also providing distrust in the foreign market. This fact emphasizes, even more, the importance of having rigid quality control, regarding the manufacture of this product and the inspection of the competent bodies in the industries in search of irregularities, both in the raw material (which may be derived from extractivism), as well as in production processes.

There are expectations of promoting exports of preserves produced with peach palm heart and royal palm from Australia. It is argued that the palm heart market could impose the need for the commercial product to have a certificate as to the sustainability of the means of its production. For this reason, there is certification of sustainable forest management for plantations established with those species. The analysis emphasizes the certification of groups of small producers and uses the NBR 14789 standard (ABNT-Cerflor system) as a reference. The expression Forest Certification, so widely popularized in recent years, refers to the certification of good forest management practices. The concept applies to both planted forests and natural forests (or native forests). The essence of the technical content of forest certification systems concerns the notion of sustainability, according to its economic, social, and environmental dimensions. In the case of commercialization of palm heart, and having as a reference the forest certification of good management practices, three hypotheses can be identified:

- Markets that import palm heart may impose conditions such as the requirement that the product have a certificate attesting to the sustainability of the production of the raw material used in its preparation;

- Producers will be able to spontaneously inform the markets that their product was produced in the context of certified sustainability (and that it incorporates a Sustainable Forestry Management Plan). This initiative will allow better access to the markets and probably the negotiation of more remunerative;

- Permanence, and growing participation, in a given market, of palm hearts whose sustainable means of production have been certified.

It is worth mentioning that the use of any forest certification system presupposes the recovery of the environmental liability represented by the lack of native vegetation that should exist in the permanent preservation areas and the legal reserve, as previously identified. For this reason, and for any certification system that may be adopted, it is required, at the level of forestry auditing, that all activities necessary for the operation of a forestry enterprise are provided for in a Sustainable Forestry Management Plan. Among the various advantages and benefits arising from the adoption of the procedure, the following can be included: a) promotion of sustainability (economic, social, and environmental) at the local and regional level; b) reduction of certification costs; c) need to correct any environmental liabilities; d) better access to palm heart import markets; e) better remuneration for production.

Before the widespread dissemination of peach palm crops across the country, there was great instability in the supply of the product to the domestic and foreign markets, these instabilities occurred since the palm heart offered during this period was of extractive origin, which generated an irregular supply. and of low quality (TONET et al., 1999). During the United Nations World Conference on Environment and Development (ECO 92), the participating countries agreed to sign an agreement in which they committed to import and export palm hearts from plantations, one of the best plantations adapted to organized planting, the peach palm.

During the last decades of the 20th century, the intense negotiations of products between nations were important factors in the period. Expansion and internationalization are alternative sources of growth and development for many organizations, avoiding the high competition in the domestic market or even as a way of escaping instability in the market in which the company is inserted, this process is widely used by the agroindustry of the palm heart. Due to the commercial potential of peach palm hearts worldwide, several Latin American countries seek to cultivate them for commercial purposes and may become competitors with the three largest exporters of palm hearts, Ecuador, Costa Rica, and Brazil (VILLACHICA, 1996). The main factors that have been increasing interest

in peach palm cultivation are the high availability of technology, which has been produced and studied, and the existence of a large international market. Despite being the second largest exporter of industrialized foods in the world, in 2011, Brazil exported US$ 5.124 million in palm hearts, representing only 1.47% of the export value of palm hearts worldwide, a fact that demonstrates that there is a large international consumer market to be conquered, justifying the need for further development, by researchers and students, of publications and studies for this agroindustry (COMEX STAT, 2020).

CONCLUSIONS

The Juçara palm is extremely targeted to illegally extract it from forests for commercialization, which makes it scarce in its origin places and with its large-scale exploitation, especially concerning the production of canned palm hearts. There is an evolutionary picture of the drastic reduction of their populations, in addition to the deforestation of the forest for illegal occupation. For this reason, farmers and experts looked for other palm trees that could produce palm hearts ecologically and sustainably, on an industrial scale to meet market demand. The main alternative species currently cultivated for palm heart production are: *Archontophoenix alexandrae*, *Bactris gasipaes*, *Euterpe oleracea*.

It is argued that the palm heart market could impose the need for the commercial product to have a certificate as to the sustainability of the means of its production. For this reason, there is certification of sustainable forest management for plantations established with such species.

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