

Review

Uses and technological prospects for the mangaba, a native fruit of Brazil

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Mangaba (*Hancornia speciosa* Gomes - Apocynaceae) is a native fruit of Brazil which is of great importance in its areas of occurrence. This species has been subjected to habitat fragmentation that is mainly due to human activity, and requires conservation. The aim of the present review was to evaluate the biotechnological advances in the species. This paper deals with recent studies on the genetic diversity and bioactive compounds.

Key words: *Hancornia speciosa* Gomes, bioactive compounds, genetic resources, conservation.

INTRODUCTION

The mangaba tree (*Hancornia speciosa* Gomes), a fruitful species in the group of dicotyledons that belongs to the Apocynaceae family, is a medium-sized plant that reaches 5 to 10 m in height. It is a native Brazilian species found spontaneously in various regions, from the Coastal tablelands and plains in the Northeastern region where it is abundant, to Cerrado areas in the Midwest; it is also present in the Northern and Southeastern regions (Vieira Neto et al., 2002).

The *Hancornia* genus is considered monotypic with its one species *H. speciosa* Gomes. Six botanical varieties are accepted according to Monachino (1945): *H. speciosa* var. *speciosa* Gomes or *H. speciosa* Gomes, *H. speciosa* var. *maximiliani* A. DC., *H. speciosa* var.

cuyabensis Malme, *H. speciosa* var. *lundii* A. DC., *H. speciosa* var. *gardneri* (A. DC.) Muell. Arg., and *H. speciosa* var. *pubescens* (Nees. et Martius) Muell. Arg. Nevertheless, further studies on the origin and occurrence of these varieties in Brazil and their participation in the formation of native populations should be conducted.

The mangaba tree is milky and deciduous with 3 to 5 m tall pendulous branches (Figure 1). The leaves are thick and leathery, glabrous and bright, reddish when young, and 4 to 10 cm long.

The flowers are fragrant, arranged in terminal fascicles, and bloom from August to November (Figure 2B). The fruits (Figure 2C) are yellowish berries with red spots and

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Figure 1. Adult tree of *Hancornia speciosa* var. *speciosa* Gomes (Source: Saulo Coelho).

stains and a meaty-viscous pulp with a sweet-acidic taste (Figure 2D). The seeds are of the recalcitrant type and have a light brown color (Figure 2E). Due to the recalcitrance of seeds, propagation has obstacles, and in addition, inhibiting substance contained in the fruit pulp may obstruct or hinder germination. The species adapts well in areas with an average temperature of 25°C, 750 to 1600 mm annual rainfall, and at altitudes of up to 1,500 m. The species shows good tolerance to drought periods and displays good vegetative development in high-temperature seasons (Ferreira and Marinho, 2007). It usually blooms twice a year. In the Brazilian Northeastern, it mainly produces fruits between October and December and smaller crops between May and July. Almost all national production occurs in the coastal tablelands and lowlands in the Northeastern region (Venturini Filho, 2010); the State of Sergipe is the largest producer in Brazil. In this state, mango is one of the most sought-after fruits in the free markets, reaching a price higher than that of grapes and other fruits considered

noble.

The name "mangaba" comes from the Tupi-Guarani language and means "good thing to eat." The mangaba tree produces aromatic, delicate, tasty, and nutritious fruits with 1.3 to 3.0% protein, 10.02% carbohydrates, 3.4% fibers, and 2.3% lipids. These fruits are also rich in components such as vitamins A, B1, B2, and C in addition to iron, phosphorus, and calcium among others (Araújo et al., 2004) (Table 1). This fruit producing tree has economic, social, and cultural importance where it is present (Silva et al., 2011). Its main product is the fruit, which is widely used in the manufacture of ice cream, pulp, juices, desserts, jams, and liqueurs (Figure 3). It is also used in popular medicine and latex production. In 2011, the commercialization of mangaba generated values around R\$ 1,000,000.00 with a production equivalent to 680 tons. The State of Sergipe in northeastern Brazil is the largest producer in the country (351 tons, IBGE, 2013).

Although the agribusiness importance of mangaba

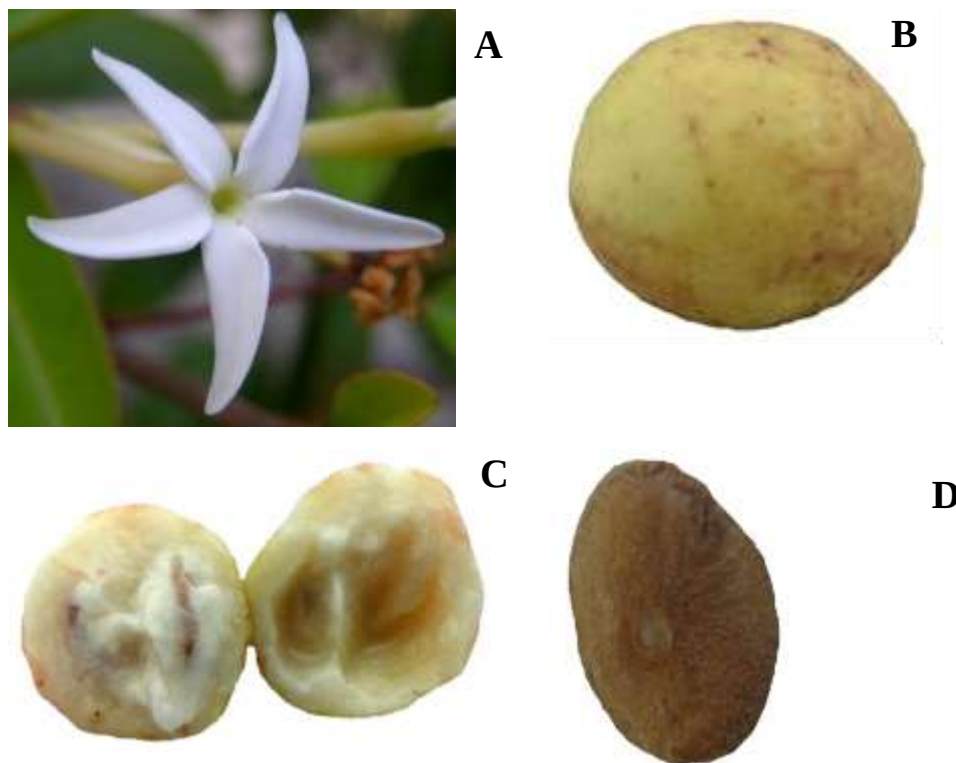


Figure 2. Flower (A), fruit (B), pulp (C), and seed (D) of *Hancornia speciosa* Gomes (Source: Adrielle N.R. Soares).

Table 1. Chemical composition in 100 g of mangaba pulp (Souza, 2005).

Primary metabolites	Quantity
Carbohydrates	10.50 g
Proteins	0.700 g
Lipids	0.300 g
Calcium	41.00 mg
Phosphorus	18.00 mg
Iron	2.800 mg
Vitamin A	30.00 mg
Vitamin B1	40.00 mg
Vitamin B2	40.00 mg
Vitamin C	33.00 mg
Niacin	0.500 mg

trees is increasing, extractive activities are still their main use. The increased marketing of mangaba products throughout the national territory is conditional to the establishment of commercial crops. To date, no variety of mangaba trees has been recorded. Inadequate exploitation of mangaba fruits associated with the fragmentation of its species' habitat promotes the existence of populations with fewer individuals and

compromises the species' future generations through natural regeneration mechanisms.

CHEMICAL ASPECTS AND NUTRITIONAL PROPERTIES

Despite the great potential for commercialization and importance of mangaba trees in their areas of occurrence, studies that address their chemical aspects are scarce and increasingly necessary.

The phytochemical study of latex provided the isolation of twelve substances with seven 3- β -O-acyl lupeol esters among them: 3- β -hexadecanoate of lupeol, 3- β -O-9-octadecenoate lupeol, 3- β -O-octadecenoate lupeol, 3- β -O-3'-hydroxy hexadecanoic lupeol, 3- β -O-3'-hydroxy hexadecanoic lupeol, 3- β -O-3'-hydroxy eicosanoic lupeol, 3- β -O-3'-hydroxy eicosanoic lupeol, a mixture containing the triterpenes α -amyrin, β -amyrin, lupeol, and one 3- β -O-3',5'-dihydroxy eicosanoic lupeol in addition to peracetylated sucrose (Sampaio, 2008).

A total of 22 substances were identified in mangaba tree leaves and branches through phytochemical studies: a mixture of the α -amyrin, β -amyrin, and lupeol triterpenes, a mixture of 3- β -O-acyl lupeol esters, and a combination of C₂₂-C₃₃ n-alkanes (Carvalho et al., 2001). Endrigger et al. (2009) isolated the L-(+)-bornesitol and



Figure 3. Uses of the mangaba fruit in food (Source: Heribert Schmitz).

rutin chemical acids from the ethanolic extract of leaves.

The effects of the fruits maturation stages on its volatile components were evaluated by Sampaio and Nogueira (2006). This study identified thirty-three compounds in unripe fruits: 1-octen-3-ol (2.8%), (Z) linalool oxide (9.1%), (E) linol oxide (6.3%), linalool (16.1%), 2-phenylethanol (4.5%), α -terpineol (5.5%), geraniol (3.1%), hexadecanol (2.5%), and octadecanol (2.7%); thirty-four compounds in the intermediate phase fruits: ethyl of ethyl propanoate (4.1%), n-propyl acetate (11.1%), 3-methyl-3-buten-1-ol (6, 8%), ethyl 2-methyl-propyl (2.5%), furfural (18.6%), (Z)-3-hexenol (3.2%), 1-hexanol (2.4%), 3-methyl-3-buten-1-yl (5.4%), (Z)-3-hexen-1-yl (2.9%), n-hexyl acetate (3.3%), (Z)-linalool oxide (3.9%), (E)-linalool oxide (2.4%), linalool (3.8%), 2-phenylethanol (2.8%), and one terpeneol (2.5%); and thirty-two compounds in riped fruits: as 3-hydroxy-2-butanone (9.1%), 2,4,5-trimethyl-1,3-dioxolane (6.8%), 3-methyl-3-buten-1-ol (12.1%), 3-methyl-1-butanol (5.2%), furfural (8.3%), ethyl 3-methyl-1-butanol (8.8%), and ethyl 3-methyl-3-buten-1-yl (28.2%).

Kubota (2007) analyzed the chemical composition of volatile compounds in fruits in the "pre-ripe" stage and identified thirty-four compounds in addition to oxygenated monoterpenes, aldehydes, alcohols, and carboxylic acid. The following compounds showed a high abundance: furfural (13.1 to 45.2%), linalool (10.6 to 21.9%), α -terpineol (7.2 to 11.8%), cis-linalool oxide (furanoid) (5.8 to 10.7%), β -(E)-damascenone (6.5 to 7.8%), trans-linalool oxide (furanoid) (3.9 to 7.4%), hexanal (2.1 to 8.6%), geraniol (1.9 to 6.4%), (2E, 4E)-decadienal (0.6 to 4.1%), and nerol (0.5 to 2.8%). Thirty-two compounds were identified in ripe fruits through hydrodistillation. Esters were the most prevalent class of compounds represented by: ethyl 3-methyl-3-buten-1-ila (26.7 to 44.7%), ethyl 3-methyl-2-buten-1-ila (2.6 to 4.5%), ethyl 3-methyl-1-butanila (1.9 to 4.8%), and 1-ethyl butanila (1.9 to 3.6%). Furfural (20.2 to 41.5%) and hexanal (2.1 to 5.1%) were the main compounds among aldehydes.

Monoterpenes were also identified in ripe fruits, however, at lower relative percentages compared to those in unripe fruits: linalool (1.9 to 4.8%), cis linalool

oxide (1.2 to 2.8%), and α -terpineol (0.1 to 0.4%).

The mangabeira fruit has high nutritional value. It is rich in vitamins (A, B1, B2, and C), iron, phosphorus, calcium, and proteins (0.7 g.100 g⁻¹ of pulp). The high iron content in the fruit pulp makes it one of the richest in this nutrient; it is also a source of ascorbic acid (Soares et al., 2006). The association between iron and vitamin C is an important feature in fruit composition because this vitamin increases iron absorption. The fruit also has other nutritional components such as small lipid content (0.3 to 1.5% S), and palmitic (29%), oleic (12%), linoleic (18%), and linolenic acid (8%). Despite the small amount of lipids, the elevated content of polyunsaturated fatty acids, considered essential to the human body, enhances the nutritional potential of the fruit (Pereira et al., 2008). Nascimento et al. (2014), in a study involving the physicochemical analysis of mangaba trees, verified that the average amount of citric acid present in fruits from different matrices was 0.98%. This result indicates that mangabeira fruits can be classified as having a moderate flavor and, thus, are well accepted for consumption as fresh fruits (Sacramento et al., 2007).

ANTIOXIDANTS AND PHARMACOLOGICAL ACTIVITIES

Antioxidant compounds are naturally present in fruits: ascorbic acid and phenolic compounds stand out among main natural antioxidants (Lima, 2011). The quantification of vitamin C in mangaba trees is relevant because this vitamin has been reported at high concentrations. Rufino et al. (2009) reported 431 mg.100 g⁻¹ vitamin C in the pulp, which is higher than those reported in strawberry, guava, and pineapple (60, 71, and 40 mg.100 g⁻¹, respectively) (Rocha et al., 2009; Oliveira et al., 2011; Sousa et al., 2011). The Germplasm Bank from the Embrapa Coastal Tablelands report values between 226.63 and 244.43 mg.100 g⁻¹ Fresh Mass (FM) of vitamin C in mangabeira fruits (Silva et al., 2015).

Phenolic compounds such as flavonoids, phenolic acids, simple phenols, coumarins, tannins, lignins, and tocopherols are derived from plants' secondary metabolism and are essential for their growth and reproduction. These compounds are responsible for color, astringency, aroma, and oxidative stability in plants (Angelo and George, 2007). Bastos et al. (2017) identified seventeen compounds described for the first time for the mangaba, of which the hydroxyl fatty acids found support for antibiotic claims and the two phenylpropanoids phloretin and phlorizin and the flavonols quercetin and kaempferol support the proposed antidiabetic properties. The results demonstrate the potential of *H. speciosa* as a source of valuable phenolics.

Flavonoids are widely present in plants; almost all plant tissues can synthesize them. Almost all flavonoids have

various common biological and chemical characteristics: antioxidant activity, ability to sequester reactive oxygen species and electrophiles, ability to inhibit nitrosation, ability to chelate metals such as iron and copper, potential to produce hydrogen peroxide in the presence of metals, and ability to modulate the activity of certain cellular enzymes (Damodaran et al., 2010). The mangaba tree is a good source of these compounds, showing concentrations of about 172 mg of gallic acid.100 g⁻¹ in the fruit (Rufino et al., 2009). Silva et al. (2015) reported values between 88.81 and 148.84 mg.100 g⁻¹ total polyphenols in a study with mangabeira entries in the Mangabeira Active Germplasm Bank (BagMangaba).

The mangaba tree is also used in popular medicine. The cork has astringent properties, and the latex is used against tuberculosis, ulcers, herpes, dermatitis, and warts. Tea made with its leaves is used to alleviate menstrual cramps; the root decoct is used to treat dislocations and hypertension (Santos et al., 2012).

Steroids, triterpenes, and tannins extracted from leaves are used to control blood pressure. In mice, it has been demonstrated that these substances are 10 times more efficient than captopril, a common drug used to control blood pressure (Silva et al., 2011). The antihypertensive effect provided by these substances found in the mangaba tree may be related to the activity of the angiotensin-converting enzyme (ACE). Angiotensin converting enzyme is stimulated by renin secreted by the kidneys in response to decreased blood perfusion. When it is released into the circulation, renin cleaves angiotensinogen, forming angiotensin I. ACE is an enzyme that acts on the conversion of angiotensin I to angiotensin II, which is a vasoconstrictor (Tamura et al., 1995). The inhibitory, vasodilating, antihypertensive, and antioxidant activities of the ACE enzyme have been demonstrated in leaf extracts (Endrigger et al., 2010). In addition to inhibiting the production of substances that cause hypertension, leaf tea has vasodilating activity through the production of nitric oxide (NO) (Ferreira et al., 2007). The nitric oxide produced by endothelial cells plays an essential role in the relaxation process of the blood vessel. Vascular tonus is normally maintained by a constant release of minute amounts of NO, resulting in a mild vasodilation (Wennmalm, 1994).

Mangabeira cork also has a potential pharmacological use. It is possible to extract different types of flavonoids, anthocyanins, and tannins from the tree cork, compounds popularly used in the treatment of stomach disorders, liver and spleen obstruction, jaundice, hepatic diseases, and chronic and skin diseases (Vieira-Neto, 1997). The anti-bacterial action against Gram-positive bacterium (*Staphylococcus aureus* and *Staphylococcus epidermidis*), Gram-negative (*Pseudomonas aeruginosa* and *Salmonella enteritidis*) and antifungal (*Aspergillus flavus*, *Candida guilliermondii*, *Rhodotorula rubra*, *Cephalosporium* species and *Trichosporon* species)

(Costa et al., 2008) and gastroprotective effect of the cork extract have been effective in combating and healing gastric ulcers because of its ability to stimulate the synthesis of mucus and produce an antisecretory effect (Moraes et al., 2008).

The *in vitro* evaluation of the chemopreventive effect of the ethanolic extract from mangabeira leaves identified L-(+)- borneol, quinic acid, and rutin, which act as NF-Kb inhibitors (antioxidant response elements) and suggests the presence of cyclitols and myoinositol as substances that may be potentially useful as chemopreventive agents (Endringer et al., 2009). The chemopreventives should act by neutralizing the carcinogenic cells, preventing initiation by means of mechanisms such as induction of detoxification enzymes, inhibition of initiation carcinogenicity, inhibition of arachidonic acid metabolism, induction of cell differentiation, inhibition of ornithine carboxylase, among others (Sporn and Suh, 2000).

The species was one of the most cited plants used for the control of hyperlipidemia and obesity in ethnobotanical research studies (Silva et al., 2010). Therefore, it is believed that this capability can also contribute to the mitigation of cardiovascular disorders.

MANGABA LATEX: TECHNOLOGICAL AND PHARMACOLOGICAL PROPERTIES

Latex was widely used during World War II in the production of rubber. Currently, the mangabeira latex is used in home medicine for the treatment of various diseases. All plant parts, including the roots, produce latex. Despite this, because it is a relatively little studied species, there is no production on a commercial scale, with the use and production of latex restricted only to the handmade form. The mangaba tree has a laticifer system with inarticulate vessels. On average, each incision in the trunk can exhaust a very limited area of 13 cm above and 5 cm below the incision. Because the vessel system is restricted, the restoration of latex takes time before the next bleeding (Pinheiro et al., 2001). Adult mangaba trees (six years) can produce 1 L of latex per bleeding in 1 or 2 h of draining; however, they can only be bled up to three times a year to allow time for latex production recovery (Bekkedahl and Saffioti, 1998).

In a study in mice, the use of latex was associated with the inhibition of nitric acid and PGE2 formation and cytokinin production, indicating an anti-inflammatory activity (Marinho et al., 2011). The antimicrobial potential of mangabeira latex against different microorganisms, such as bacterium and fungi, has been demonstrated in studies with rabbits (Santos et al., 2007). Another therapeutic property of latex was described by Sampaio (2008), who carried out biochemical tests in mice and determined that mangabeira latex demonstrated antioxidant activity and a significant hepatoprotective effect.

Silva et al. (2011) demonstrated that the mangabeira latex also presents antimicrobial activity through a significant effect against *Candida albicans*. The latex showed efficiency in the induction of angiogenesis by promoting a healing process without genotoxic and cytotoxic activities (Almeida et al., 2014).

Due to an increased search for alternative sources of natural rubber with properties similar to that of *Hevea brasiliensis*, other sources, including the mangaba tree, have been studied. The technological properties of the mangabeira latex are quite similar to those of *H. brasiliensis* (Malmonge et al., 2008). Mangabeira latex has a lower protein content than *Hevea*, a fact that suggests its latex may have important application in situations requiring the use of anti-allergenic rubber (Medeiros et al., 2010).

Researches involving *H. speciosa* latex were carried out, and twelve chemicals mentioned earlier were identified. In studies conducted by Uzabakiliho et al. (1987), it was possible to verify that the latex of *H. brasiliensis* has a more complex composition when compared with that of *H. speciosa*. The latex of *H. brasiliensis* is composed of a complex mixture of different components, including macromolecules. One of the major components of the latex is cis and/or trans polyisoprene. Constituents present in latex are rubber, proteins, carbohydrates, neutral lipids, polar lipids, inorganic components, amino acids, amines and water. Besides these, other constituents present in latex and reported in phytochemical studies are: polysaccharides, flavonoids, lipids, phospholipids and proteins; alkanes, triterpene ketones, triterpenoids, sugars and fatty acids were also confirmed (Table 2).

CONSERVATION OF GENETIC RESOURCES

The improper exploitation of mangaba fruits associated with the fragmentation of the species' habitat promotes the existence of populations with fewer individuals and compromised future generations through natural regeneration mechanisms. Over time, this condition can lead to less vigorous individuals and reduced genetic variability in natural populations with the possible loss of economically important traits. Thus, the definition of *ex-situ* strategies is essential for the conservation of the existing genetic variability in natural populations.

Genetic materials or germplasms are living physical units with reproductive potential which contain the genetic makeup of a particular organism. Thus, depending on the species, germplasm can be collected, worked, and stored in the form of seeds, seedlings, cuttings, pollen, or even in tissue culture (Balick, 1989). The establishment of germplasm banks is essential to preserve species, genes, and alleles in order to guarantee future characteristics of economic, environmental, and social interest, among others (Mazzocato et al., 2014).

Table 2. Plant parts and popular medicinal use of the mangaba tree.

Plant part	Popular medical uses	References
Fruits	Tuberculosis, ulcers, skin diseases, warts, bruises, various inflammations, diarrhea and herpes.	Sampaio (2008)
Latex	Tuberculosis, ulcers, warts, bruises, various inflammations, diarrhea, herpes, dislocation, diabetes, obesity, bone regeneration, bactericide	Sampaio (2008), Santos et al. (2007), and Pott and Pott (1994)
Cork	Hypertension, gastric ulcers, stomach disorders, processes, inflammatory lung diseases, cramps and dislocations	Almeida et al. (1998) and Silva Júnior (2005)
Eaves	Dysmenorrhea, diabetes, obesity, warts, menstrual cramps, hypertension, rheumatism	Almeida et al. (1998), Silva Júnior (2005), and Hirschmann and Arias (1990)
Roots	Hypertension and rheumatism	Hirschmann and Arias (1990)

Prior to 2006, there were only two germplasm collections in Brazil: one belonging to the Pernambuco State Company of Agricultural Research (IPA), initiated in 1970 and containing 125 entries; and another in the Paraíba State Company of Agricultural Research - EMEPA-PB, implemented in 1991 and currently containing 220 entries (Souza et al., 2007).

The mangaba tree is on the list of species at risk of extinction because large areas where these trees naturally occur are being devastated. Therefore, in 2006, the Embrapa Coastal Tablelands installed the Mangabeira Active Germplasm Bank (BAGMangaba) (Figure 4) in the State of Sergipe as an alternative mechanism for maintaining the genetic diversity of this important tree. Collecting expeditions have been conducted since 2006 in various regions where the species occur (Silva et al., 2011).

BAG represents a collection of genes and a reservoir of natural genetic variability, which are essential for the species' breeding programs (Costa et al., 2011). The characterization of available entries preserves genetic diversity (Coimbra et al., 2012) and is fundamental to an understanding of their potential, thereby identifying the variability between and among populations (Lima et al., 2012).

Characterization of existing samples in a germplasm bank enables the gathering and preservation of maximum genetic variability with minimum duplications in addition to promoting and providing genetic material for breeding programs. The evaluation of genetic diversity between different entries at BAG affords information about potential parents for use in breeding programs and enables the identification of duplicates and exchange of germplasm among researchers. It is a way to reconcile agrobiodiversity conservation efforts with sustainable development. Characterization of existing samples in a germplasm bank allows the gathering and preservation of

maximum genetic variability with minimum duplications, in addition to promoting and providing genetic material for breeding programs (Manfio et al., 2012).

In addition to the Germplasm Bank, the *in situ* conservation of species is also ongoing. In the state of Sergipe, the work of Mangaba pickers, already described in the literature (Silva Júnior, 2003; Mota and Silva Júnior, 2005; Mota and Santos, 2005), has allowed the association between conservation of biodiversity and traditional knowledge with low impact on the environment.

GENETIC DIVERSITY

Genetic diversity is one of the most important parameters evaluated by plant breeders in the early stages of a breeding program. Many methods are available to assess it in plant populations and differ in their ability to detect differences between genotypes (Morales et al., 2011). Such quantification of genetic diversity can be achieved by means of agronomic, molecular, and morphological characters among others (Amorim et al., 2007).

Genetic variability is the multiplicity of allelic frequencies present in a group of individuals that, along with the environment, provides a range of phenotypes, which represents the fundamental basis of genetic improvement programs. Exploiting the diversity of cultivated species of economic importance is a fundamental task in all agricultural research programs (Cardona, 2010).

In plant breeding programs, information related to diversity is of fundamental importance because it allows the identification of hybrid combinations that can produce high heterosis effects in addition to providing increased genetic variability in segregating generations (Bahia et al., 2008; Gonçalves et al., 2009; Rocha et al., 2009).

Furthermore, it enables the identification of duplicates



Figure 4. Mangabeira Active Germplasm Bank of the Embrapa Coastal Tablelands, Itaporanga d'Ajuda, Sergipe, Brazil. (Source: Ana Veruska Cruz da Silva).

and, thus, considerably reduces expenses in the maintenance of germplasm banks (Rodrigues et al., 2002).

Knowledge of the degree of genetic variability through divergence studies is essential in the process of identifying new sources of genes of interest (Falconer and Mackay, 1996). Molecular markers, identifiable DNA sequences found at specific genome locations that are transmitted by the common laws of inheritance from one generation to another (Rodrigues, 2013), emerged as an important tool in plant genome analysis because they provide information on genetic variability and identify polymorphisms in any stage of development (Bicalho, 2006), thereby contributing significantly to the basic knowledge of crop.

Molecular characterization stands out as a way to evaluate genetic diversity, allowing inference of the degree of diversity among individuals and populations

based on molecular markers, markers, which are independent of environmental effects. In general, molecular markers are based on the amplification of DNA fragments by polymerase chain reaction (PCR) and have been widely used in plant breeding programs. For example, they are used in the study of population genetic diversity in the evaluation of the potential of available genetic resources and their associations with agronomic characteristics (Benko-Iseppon et al., 2003).

The establishment of cultivated varieties requires enough genetic diversity to allow the selection of individuals that can be used in breeding programs. Therefore, the study of the components of species variability is critical, especially in native species that are not well studied and whose magnitude of diversity is not fully understood (Costa et al., 2011).

The RAPD (Costa et al., 2011; Silva et al., 2011), ISSR (Soares et al., 2016; Amorim et al., 2013) and SSR

(Amorim et al., 2015) molecular markers have been reported as showing genetic diversity in mangaba trees. The studies using SSR markers in natural populations and in BagMangaba entries use primers developed by Rodrigues et al. (2015).

Although the mangaba tree is economically important, studies on this species are recent, and a better understanding of the genetic structure and diversity of this species' natural populations and existing collections is needed in order to assist the conservation of these genetic resources.

CONCLUSION

Due to the economic, pharmacological, and nutritional importance of the mangaba tree, an increased understanding of its production system is necessary. One of the main goals of fruit producers in Northeastern Brazil is to add value to regional fruit trees because they are usually exploited through extractivism. Therefore, it is believed that the biotechnological knowledge involving chemistry, biochemistry, and molecular biology can add information to assist in the use of the various parts of mangaba trees as inputs for the food and pharmaceutical. These actions could lead to improved income for producers and the heating of regional economies.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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