



Figura 3. Number of *Spondias* accessions preserved in the germplasm collections of the Embrapa Units, 2014.
Legend: Embrapa Semiariid (CPATSA), Embrapa Mid-North (CPAMN), Embrapa East Amazon (CPATU), and Embrapa Cassava & Fruits (CNPMPF).

Researchers

Cristina de Fátima Machado
 Viseldo Ribeiro de Oliveira
 Maria Clideana Cabral Maia
 Rafael Moysés Alves
 Rogério Ritzinger
 Walter dos Santos Soares Filho
 Nelson Fonseca

Embrapa Cassava & Fruits
 Cruz das Almas, BA
 +55 (75) 3312-8048
www.embrapa.br/mandioca-e-fruticultura

Embrapa Semiariid
 Petrolina, PE
 +55 (87) 3866-3600
www.embrapa.br/semiarido

Embrapa Mid-North
 Teresina, PI
 +55 (86) 3198-0500
www.embrapa.br/meio-norte

Embrapa East Amazon
 Belém, PA
 +55 (91) 3204-1000
www.embrapa.br/amazonia-oriental

Information

www.embrapa.br
www.embrapa.br/fale-conosco/sac



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Germplasm Bank of *Spondias* at Embrapa



THE

he species of the genus *Spondias* belongs to the family Anacardiaceae and is found in Asia, Oceania and the Neotropics. In Brazil, its diversity centers are the Atlantic Forest and the Western Amazon, covering an area that stretches from the State of Acre to the neighboring regions of Peru and Bolivia. The main species of *Spondias* are the umbu or imbu (*S. tuberosa* Arruda Câmara); cajá or taperebá, as it is known in the North Region (*S. mombin* L. - sin. *S. lutea* L.); seriguela (*S. purpurea* L.); cajarana or cajá-mangueira (*S. dulcis* Forst - sin *S. cyntherea* Sonn.); and the natural hybrids cajá-umbu and umbu-cajá (*S. mombin* x *S. tuberosa* and *S. tuberosa* x *S. mombin*, respectively), which are endemic to Northeastern Brazil. Cajaguleira (*S. mombin* x *S. purpurea*) and umbugueleira (*S. tuberosa* x *S. purpurea*), all fruit trees; are exploited through extractivism and with great potential for agroindustrial exploitation. Other species with edible fruits are *S. macrocarpa* Engl. (cajá redondo), *S. venulosa* Mart. Ex Engl. (cajá pescoço), *S. testudinis* Mitch. and Daly (cajá jabuti) and groups of sympatric species occurring in distinct regions of Central America, such as *S. mombin* and *S. radlkoferi* Donn. Smith. These species are in the process of domestication with little information about their genetics and distribution of their genetic variability. Cytogenetics studies regarding the genus *Spondias* is practically unknown. The only available cytological data is the chromosome number (2n = 32) present in the following species: *S. pinnata*, *S. mombin*, *S. tuberosa*, *S. cyntherea*, *S. purpurea*, *S. venulosa* and *Spondias bahiensis* - umbu-cajazeira. In the case of interspecific hybrids the genomes of the parents are usually very similar. Thus, in order to avoid the risk of genetic erosion and to optimize the use of these species, it is necessary to establish effective strategies for ex-situ conservation, seeking to recover the existing variability for use in genetic breeding programs. The *Spondias* Germplasm Bank (GB) was established at Empresa Brasileira Pesquisa Agropecuária (Embrapa) in 2000, with the following main activities: (1) conservation of the *Spondias* genus genetic resources and (2) characterization, evaluation, exchange and documentation of this germplasm. These activities are conducted in an integrated way in the collections of the following Embrapa decentralized units: Embrapa Semiarid, in Petrolina, PE; Embrapa Mid-North, in Teresina, PI; Embrapa East Amazon, in Belém, PA and Embrapa Cassava & Fruits, in Cruz das Almas, BA. Each Unit collects, preserves, exchanges, documents, characterizes and evaluates the germplasm from representative areas of different ecosystems, which together forms the Brazilian *Spondias* Germplasm Bank. The management of the GB comprises the execution of these activities, as well as availability of accessions, which should cover

the greatest possible genetic variability, seeking to prevent genetic erosion, as well as the identification of useful genes with adaptive value, particularly as to main environmental biotic and abiotic stresses. Figures 1 and 2 illustrate the biodiversity of the *Spondias* species, regarding the botanical and morphological characteristics of flowers and fruits.

COLLECTION AND CONSERVATION: Currently, Embrapa's *Spondias* GB comprises four collections with a total of 182 accessions belonging to species of immediate interest and / or potential for breeding (*S. tuberosa*, *S. mombin*, *S. purpurea*, *S. bahiensis*). Of this total, *S. tuberosa* has the highest number of accessions (Figure 3). Accessions are maintained under field conditions, in the decentralized units of Embrapa, as well as in seed banks (collection base: Colbase) at Embrapa Genetic Resources & Biotechnology and Embrapa Semiarid. The accessions were obtained through collection expeditions in the following regions: (1) Northeast - Embrapa Semiarid GB (PE, BA, and RN (Figures 1e, 1i); Embrapa Cassava & Fruits GB (BA and RN) (Figures 1c, 1d, 1f, 1g, 1h, 1j, 1k, 1l); and Embrapa Mid-North GB (PI and MA) (Figure 1a) and (2) North - Embrapa East Amazon GB (PA (Figure 1b); and by exchange of germplasm from other research institutions. These accesses are propagated vegetatively, except for umbu and cajá, which, due to seeds in their endocarps, propagate both by sexual and asexual methods by cuttings and grafting methods. The practices of maintenance of the BG follows the suggested recommendations for each species.



Figura 1. Accessions of *Spondias* maintained in field conditions at Embrapa Cassava & Fruits, Cruz das Almas, BA (c, d, f, g, h, j, k, l); Embrapa Semiarid, Petrolina, PE (e, i); Embrapa East Amazon, Belém, PA (b); and Embrapa Mid-North, Teresina, PI (a), 2014.



Photos: Cristina de Fátima Machado

Figura 2. Diversity of *Spondias* species in the GB, regarding the characteristics of fruits. Cruz das Almas, Bahia, 2014.

CHARACTERIZATION AND EVALUATION: Morphological characterizations and agronomic evaluations are carried out from a list of descriptors, which include vegetative traits, inflorescence and fruit characteristics, and analysis related to the physical and chemical composition of fruit pulp. For the molecular characterization, ISSR (Inter Simple Sequence Repeat) markers are used. These descriptors are used to identify and document morphological aspects of high heritability as well as molecular patterns in order to generate subsidies for the potential use of the accessions. Requests for exchange of material from partner institutions are analyzed by the curatorship of the GB and met according to the availability of material, in compliance with the internal rules of Embrapa and the Brazilian legislation for the transfer of plant material.

POTENTIAL USE: The results of germplasm characterization studies based on agronomic, morphological and molecular characteristics have allowed the indication of superior genotypes to be used directly as cultivars or with potential for use in breeding programs. In this context, the fruits of umbu-cajazeira, umbuzeiro, seriguleira and cajazeira have pleasant and attractive aroma, although, in most cases, the acidity is high and the ascorbic acid content is not very expressive, except in the fruits of seriguleira (Table 1). However, there is considerable variability in size, taste, color and aroma, and it is possible to select promising commercial genotypes. The results allowed to obtain promising accessions for agronomic and agroindustrial aptitude or purposes. Therefore, the morphological, agronomic, physical and chemical characterization of fruits, associated with the use of molecular tools can provide useful information to the breeders of the species studied.

DOCUMENTATION AND PARTNERS: The passport data are organized in electronic spreadsheets and available on the Internet (<http://alelobag.cenargen.embrapa.br/Acessar/NEWBAG>), while the inventory of the collection is documented in the Embrapa's curatorship system. Several collaborators are involved in various activities of the GB, which has a multidisciplinary team of researchers (biologists, geneticists, breeders, plant pathologists, agronomists and technology transfer professionals). In addition to the Embrapa/Units, the work with genetic resources of *Spondias*, relies on a network of institutions that involves the Universidade Federal do Recôncavo of Bahia (UFRB), Empresa de Pesquisa Agropecuária do Rio Grande do Norte (EMPARN) and the Instituto Agrônomo de Pernambuco (IPA), to add efforts in the activities of enrichment, conservation, characterization, evaluation, documentation, and training of human resources.

Tabela 1. Variation in the ascorbic acid (vitamin C) and fruit characteristics of 20 *Spondias* genotypes from Embrapa Cassava & Fruits genebank, Cruz das Almas, BA, 2012/2013; and variation of fruits characteristics of 79 umbu genotypes from Embrapa Semiarid genebank, Petrolina, PE, 2014.

Germplasm Bank of <i>Spondias</i> at Embrapa Cassava & Fruits		
Characteristics	Minimum	Maximum
Fruit length (cm)	3,14	4,44
Fruit width (cm)	2,38	3,51
Fruit weight (g)	10,25	30,48
Weight of fruit skin (g)	1,73	5,39
Seed weight (g)	1,66	6,54
Pulp weight (g)	6,80	20,63
Pulp/seed ratio	2,63	7,60
Yield (%)	57,59	75,73
Titrateable acidity - TA (%)	1,43	2,59
Soluble solids – SS (°Brix)	8,87	15,43
SS/TA ratio	3,57	10,49
pH juice	2,16	2,87
Vitamin C (mg/100g)	3,41	55,71
Germplasm Bank of Umbu at Embrapa Semiarid		
Characteristics	Minimum	Maximum
Fruit width (cm)	2,50	5,33
Fruit weight (g)	4,88	85,00
Weight of fruit skin (g)	1,37	22,50
Seed weight (g)	0,30	10,00
Pulp weight (g)	3,60	58,00
Soluble solids – SS (°Brix)	8,90	14,80