Case 8. Use of Brazilian genetic diversity in cassava breeding program

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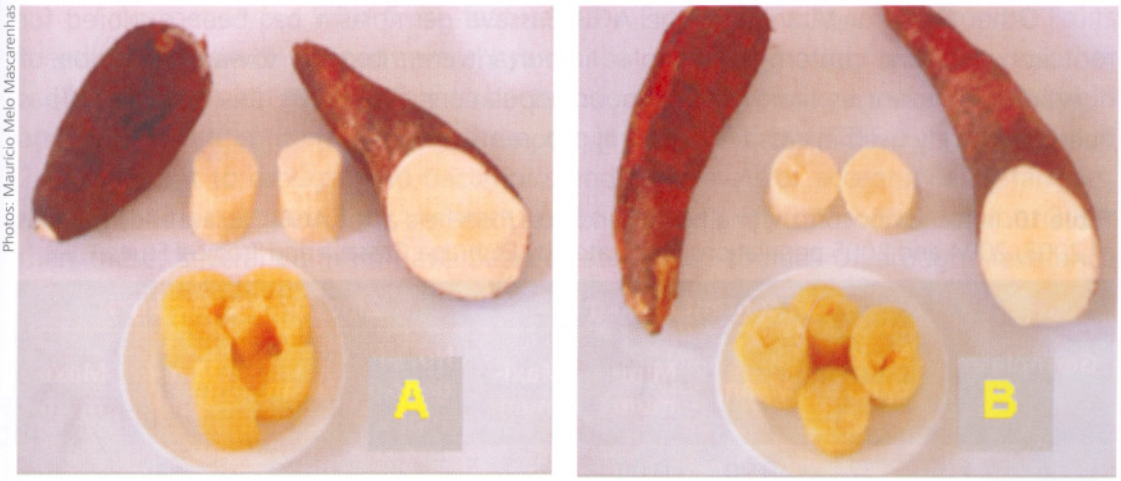
In Brazil, Cassava has a wide genetic diversity chiefly represented by landraces, and the country is considered as the possible center of origin and diversification of cultivated cassava. About 4,132 cassava accessions have already been catalogued in Brazil, and they are stored in collections and germplasm banks disseminated over the national territory. Brazilian diversity constitutes a wide genetic base for cassava breeding programs in all tropical areas in the world, as it includes resistance genes to main pests and diseases affecting this crop. Furthermore, these genes allow adaptation to different edapho-climatic conditions. Indeed, genetic variability had already been identified for almost all features, including morphological, agronomic, as well as nutritional quality and technological features. Variations for physiological features are more seldom studied, but there is evidence indicating high variability as a consequence of temperature, photosynthesis and sensitivity of stomata to relative humidity of the air. Although Brazil's cassava genetic resources are not very much exploited relative to the collections' size, its use is extremely successful in our country.

Root carotene, iron and zinc content

Vitamin A deficiency prevails in some areas of the Brazilian Northeast where cassava is widely grown and is the main staple food for the population; so, this crop is an excellent means to overcome nutritional deficiencies in this region. It was recently confirmed that, other than carbohydrate, cassava presents diversity for iron, zinc and root carotene content, where there is a high correlation between yellow root color and carotenoid content. The approximately 1,800 cassava accessions held in the AGB-cassava, located in Cruz das Almas (Bahia state), and were evaluated in order to identify accessions with roots richest in carotenoids. Cassava plants with higher and lower root hydrogen cyanide (HCN) content were used as parents for the development of new hybrids with higher root content (Figure 21).

Hybrids were developed from crossing carried out in the framework of the cassava breeding program conducted at Embrapa Cassava and Tropical Fruits; gains in root total carotenoids in these hybrids were 209.4% compared with parents, with a maximum of 12 µg/g of root total carotenoids (fresh weight), as well as low HCN root content and good quality for fresh consumption (Table 9 and Figure 22).



Photos: Maurício Melo Mascarenhas

Figure 21. BRS Dourada (golden) (A) and BRS Gema de Ovo (egg yolk) (B), cassava cultivars launched for commercial cultivation from selections made in AGB-Cassava for carotene content and low root HCN.

Table 9. Total carotenoid content ($\mu g.g^{-1}$) (fresh weight) in populations developed by Embrapa Cassava and Tropical Fruits (families 2003 and 2004).

Germplasm	Family 2003 (228 genotypes)			Family 2004 (136 genotypes)		
	Carotenoid content			Carotenoid content		
	Mean	Minimum	Maximum	Mean	Minimum	Maximum
Progenitors	2.84	2.84	1.50	3.37	2.14	4.01
Hybrids	4.49	4.49	0.87	6.21	2.76	12.41
Gain	58.1%	-42%	**146%**	84.2%	28.9%	**209.4%**

Photos: Maurício Melo Mascarenhas

Figure 22. Cassava hybrids created for elevated root carotenoid content using germplasm selected from the AGB-cassava.

This material, adapted to poor Brazilian Northeastern regions where Vitamin A deficiency is a concern, certainly is one of the important contributions of native cassava germplasm to Brazil.

Other than for Vitamin A, the AGB-Cassava germplasm has been explored for root iron and zinc content, resulting in important contributions toward reduction of nutritional deficiencies (iron, zinc) in poor populations (Table 10); this germplasm has been intensively used in cassava breeding programs.

Table 10. Iron and zinc content ($mg.kg^{-1}$) in landraces roots held at the AGB-Cassava and in hybrids of 2003, 2004 and 2005 populations, generated by Embrapa Cassava and Tropical Fruits.

Germplasm	Iron content ($mg.kg^{-1}$)				Zinc content ($mg.kg^{-1}$)			
	No. of genotypes	Mean	Minimum	Maximum	No. of genotypes	Mean	Minimum	Maximum
Landraces	72	9.20	0.00	56.50	72	4.14	0.00	26.20
2003 populations	179	8.20	0.00	511	179	5.20	0.00	34.10
2004 populations	136	13.10	1.00	77.50	136	12.50	0.50	87.10
2005 populations	40	23.80	20.54	30.65	40	7.94	1.97	34.38

Drought resistance

Current research with the goal of identifying sources of drought resistance is also worth mentioning. About a thousand cassava accessions were initially evaluated in four ecosystems in the Northeastern Semi-Arid region. Genotypes were identified that are tolerant to drought periods of up to 8 months while maintaining good root and aerial parts production; this latter is extremely important to feed animals during long drought periods (Figure 23).

Photo: Wania Maria Gonçalves Fukuda

Figure 23. Drought resistant cassava germplasm selected from AGB-cassava.

From genotypes with these features, the Embrapa Cassava and Tropical Fruits breeding program developed several hybrids that combine drought resistance to other useful features such as resistance to bacteriosis and *Phytophthora* root rot, good yield and root starch content. Among these genotypes stand out 'BRS Formosa' (Figure 24a), resistant to drought and bacteriosis and high levels of acceptance by farmers, and 'BRS Kiriris' (Figure 24b), resistant to drought and *Phytophthora* root rot. Other than these, several cultivars have been created from sources of drought resistance identified in AGB-cassava.

Photos: Chigeru Fukuda

Figure 24. BRS Formosa (A) and BRS Kiriris (B), cassava hybrids resistant to drought, obtained from clones selected from AGB-cassava.

Unusual starch and hydrogen cyanide content

The exploitation of AGB-cassava in order to identify unusual starches will certainly lead to an increase in this crop added value due to its high quality for industrial utilization. Furthermore, edible cassava exports to Japan and some European countries will be encouraged by the conventional plant breeding currently being carried out with AGB-cassava germplasm, which has already achieved a decrease in hydrogen cyanide root content down to 12ppm.