# Development of cassava cultivars with high iron and zinc contents in their roots

Wania Maria Gonçalves Fukuda[1]; Antonia Fonseca Jesus Magalhães[1]; Márcio Eduardo Canto Pereira[1]; Luciana Alves de Oliveira[1]; Hernan Ceballos[2]; Marília Nutti[3]; José Luiz Viana de Carvalho[3]

## Introduction

The micronutrients iron (Fe) and zinc (Zn) are major world nutrition deficiencies, mainly for underdeveloped countries and poor communities.

Iron deficiency is the most common micronutrient deficiency in the world. However, global data for iron deficiency does not exist and anemia is used as an indirect indicator. More than two billion people worldwide are anemic and much of it is due to iron-deficiency. Iron deficiency during childhood and adolescence impairs physical growth, mental development, and learning capacity. In adults, it reduces the capacity to do physical labor (HarvestPlus, 2006b).

Zinc is essential for survival and deficiency has serious consequences for health. Zinc supplementation can reduceby one third the severity of morbidity from a number of common childhood infections, including diarrhea, pneumonia, and possibly malaria. Because of inadequate intakes, billions of people are at risk for zinc deficiency (HarvestPlus, 2006b).

Current efforts to alleviate micronutrient deficiencies focus on providing vitamin and mineral supplements continuously, which requires a considerable annual financial support. As an alternative to supplementation, an international program (HarvestPlus – Biofortification Challenge Program) was started to reduce micronutrient malnutrition through breeding nutrient-dense staple crops.

An estimated 70 million people obtain more than 500 calories per day from cassava, one of the crops targeted by the HarvestPlus Program. It was found that besides carbohydrates, yellow cassava roots are also a good source of carotenoids, with ß-carotene being frequently the most common form. There are also evidences that cassava may offer adequate variability of Fe and Zn contents in its roots, but germplasm must be explored in order to select top accessions for breeding purposes (Chávez et al., 2005; HarvestPlus, 2006a). This work aimed to quantify iron and zinc contents in yellow cassava varieties and hybrids.

## Materials and methods

Fe and Zn contents in roots of 72 cassava varieties were quantified. These varieties had been previously selected for carotenoid content in roots from the Cassava Germplasm Bank at EMBRAPA Cassava & Tropical Fruits, located in Cruz das Almas, Bahia State, Brazil. In addtion a groups of 172 hybrids (Family 2003) and 136 hybrids (Family 2004) all with yellow roots were also evaluated, as well as their progenitors. Varieties are landraces collected from farmers' fields whereas hybrids refer to genotypes that have been developed through directed crosses by the cassava breeding project at EMBRAPA.

Roots were collected early in the morning and taken to the laboratory where they were washed with tap water to remove residual earth and peeled. The pulp was cut longitudinally into quarters and two opposite slices were taken for analysis. The longitudinal slices were dipped in destilled water and in Milli-Q type water, air dried and chopped into small pieces, which were then homogenized in a domestic food processor. All these steps were done with stainless steel knives and blades. The homogenate was placed on a petri dish to be oven dried (60-65°C) for 24 hours. A small sample (5-8g) of the dried material was ground on a Retsch mixer mill MM 200 equipped with zirconia-made jars and balls. Samples were then taken for an acid digestion and analyzed for iron and zinc contents by atomic absorption. Results were expressed in mg/Kg.

## Results and discussion

Contents for Fe in landraces ranged from 0 mg/Kg to 56,5 mg/Kg, with 23 of them (31,9%) had higher contents than the average (9,2 mg $Kg^{-1}$). For the group of cassava hybrids (Family 2003), the average content of the 179 hybrids was 8,2 mg $Kg^{-1}$ as a reference the average Fe content of the progenitors of these hybrids was 6,1 mg $Kg^{-1}$. There were 35 hybrids with Fe contents above the average. For the second group of hybrids (Family 2004) the 136 hybrids averages 13.1 mg $Kg^{-1}$ with values ranging from 1.0 mg $Kg^{-1}$ to 77,5 mg $Kg^{-1}$.

The distribution of Zn contents in the samples analyzed is presented in Table 2 and Figure 2. The Zn contents of the landraces ranged from 0 mg/kg to 26.2 mg $Kg^{-1}$ with na average of 4.14 mg $Kg^{-1}$, and 26 of them (36,1%) had higher Zn contents than the average.

For the first group of 179 cassava hybrids, Zn content ranged from 0.0 to 34.1 mg $Kg^{-1}$, with an average of 5.2 mg $Kg^{-1}$. 62 of these hybrids (34,6%) presented Zn contents above the average. As a reference, the progenitors of these hybrids averaged 4,27 mg $Kg^{-1}$. In the second group of 136 hybrids, Zn

content ranged from 0.5 to 87.1 mg $Kg^{-1}$, with an average of 12.5 mg $Kg^{-1}$. 56 of the 2004 hybrids (41%) presented Zn content above the average. The progenitors of the 2004 hybrids averaged 3.37 mg $Kg^{-1}$. Superior accessions have been crossed to produce new segreganting populations in order to select elite and adapted genotypes for roots with high levels of Zn.

## Conclusions

It was concluded that there is a adequate variability of Fe and Zn content in cassava roots. It would be possible to make specific crosses to obtain higher Fe and Zn contents in the roots of cassava hybrids and, therefore, these traits are potential targets to be included in the cassava breeding project at EMRAPA-CBPMF.

## Acknowledgements

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## References

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Table 1. Iron (mg.Kg $^{-1}$) contents in Landraces varieties and hybrids of cassava roots

| Varieties/ Hybrids | Number of genotypes | Average (mg Kg-1) | Minimum (mg Kg-1) | Maximum (mgKg-1) |
|---|---|---|---|---|
| **Landraces** | 72 | 9,2 | 0,0 | 56,5 |
| 2003 | 179 | 8,1 | 0,0 | 51,1 |
| 2004 | 136 | 13,1 | 1,0 | 77,5 |

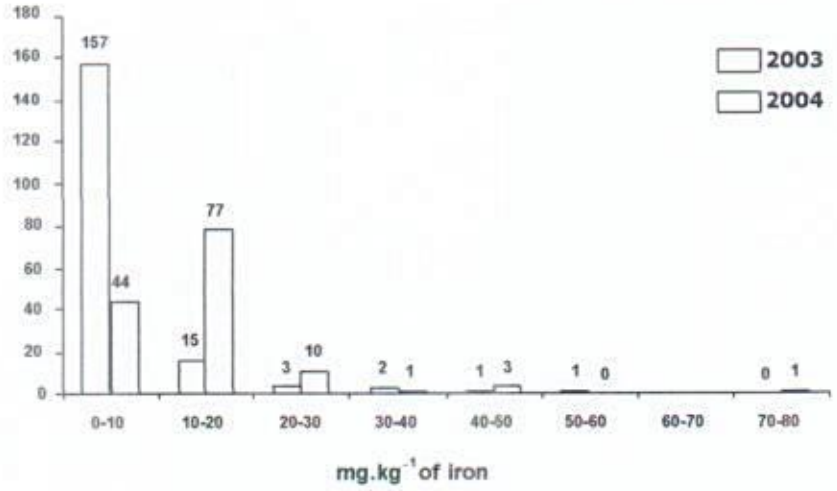


Figure 1. Iron contents (mg Kg-1) in hybrids of the 2003 and 2004 generations

Table 2. Zinc (mg.Kg $^{-1}$) contents in Landraces varieties and hybrids of cassava roots

| Varieties/ Hybrids | Number of genotypes | Average (mg Kg-1) | Minimum (mg Kg-1) | Maximum (mgKg-1) |
|---|---|---|---|---|
| Landraces | 72 | 4.1 | 0.0 | 26.2 |
| 2003 | 179 | 5.2 | 0.0 | 34.1 |
| 2004 | 136 | 12.5 | 0.5 | 87.1 |

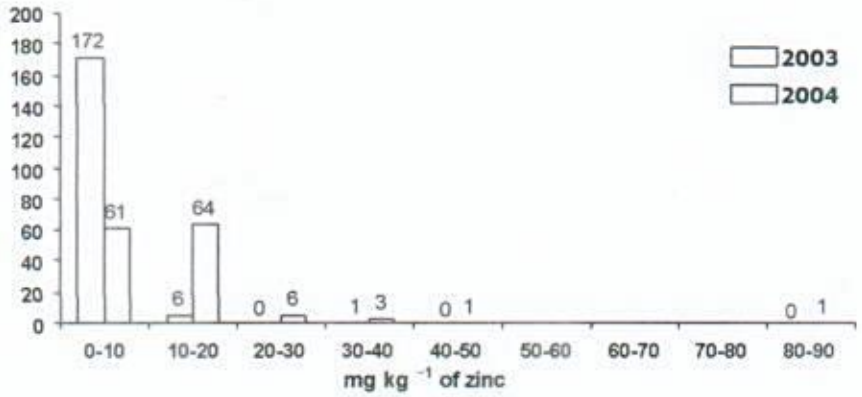


Figure 2. Zinc contents (mg.Kg $^{-1}$) in hybrids of the generation 2003 e 2004