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TH23 THE BIOFORTIFICATION PROGRAM IN BRAZIL

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Most efforts to combat micronutrient deficiency in the developing world focus on providing vitamin and mineral supplements to the poor and on fortifying foods with these nutrients through postharvest processing. The introduction of biofortified crops – varieties bred for increased mineral and vitamin content – could complement existing nutrition interventions and provide a sustainable, low-cost way of combating malnutrition. In Brazil, the activities of the HarvestPlus Challenge Program on Biofortification and of the AgroSalud Program are coordinated by the Brazilian Agricultural Research Corporation (Embrapa), which includes a number of research centers that are part of the biofortification network. The difference between both programs is that AgroSalud focuses on the Latin America and the Caribbean, and also on post-harvest processing. The main food staples under research in Brazil are: cassava, sweet potato, rice, common beans, maize, cowpea and wheat . Embrapa Cassava and Tropical Fruits has already released two varieties of cassava with higher levels of beta-carotene and, in the last two years, is monitoring their performance in the semi-arid region of the country. Total carotenoid content in one-year old roots of the 72 landraces selected ranged from 0.63 to 15.51 ug.g-1 (fresh weight). Retention studies were carried out, at Brazilian Universities, in order to verify the β-carotene and total carotenoid losses in the usual Brazilian household cassava preparations. The production of bakery and extruded products, using biofortified cassava flour, was evaluated at Embrapa Food Technology .Researchers of Embrapa Maize and Sorghum implemented the quality protein maize (QPM), which has 50% more lysine and tryptophan; from these QPM varieties, it is expected the development of maize with higher levels of pro vitamin A (10 – 12 ug.g-1) , zinc and iron. Some common beans genotypes evaluated by Embrapa Rice and Beans, presented iron and zinc levels 50% and 43% higher than the ones of conventional cultivars, respectively; however, the productivity is still a challenge for the breeders. Also, a cowpea variety, with higher levels of iron was identified by Embrapa Mid-North and will be released in 2008.. Six biofortified crops are being produced locally for sensory analysis and agronomical performances in Maranhao and Sergipe States, along with antropometrical status Results presented here are based on a team work strategy, integrating more than 150 people in different geographical areas, and working tightly in order to reach HarvestPlus and AgroSalud expected deliverables.

TH24 BIOFORTIFIED COMMON BEAN GENOTYPES (PHASEOLUS VULGARIS, L.) AS IRON AND ZINC SOURCES IN BRAZILIAN POPULATION DIET

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The common beans (Phaseolus vulgaris, L.) have an important role as a source of nutrients (proteins, carbohydrates, vitamins and minerals) and dietary fiber for Brazilians as a product present daily at both rural and urban people's diet. Regarding minerals, common beans are especially rich in potassium, phosphorus, copper, iron, zinc and magnesium. The bioavailability of minerals is relevant and normally lower in vegetables. Some factors can affect bioavailability, such as food digestibility, chemical state of the mineral, other mineral content in the diet, the chelating agents presence. Iron and Zinc are essential minerals for the human metabolism. Zinc has antioxidant properties and is part of many enzymes, influencing brain control of muscles, assuming structural, enzymatic and regulating functions on the human body. The aim of this work was to evaluate common bean genotypes originated from CIAT's (International Center of Tropical Agriculture) high mineral nursery, in order to identify sources with high iron (100 ppm) and zinc (50 ppm) contents which can be considered biofortified seeds for consumption by malnourished Brazilian people especially from the Northeast region. 81 common bean genotypes were originated from CIAT's high mineral nursery and multiplied in Santo Antonio de Goias, Goias State, Brazil, at Embrapa Rice and Beans. Under irrigated conditions, the grains were harvested in September/2007 and evaluated for iron and zinc contents after a very strict preparation of the samples, avoiding mineral contamination, mainly by iron, since harvest. The mineral levels were determined by AOAC with some adjustments, using nitro-perchloric digestion (2:1) of the sample flour (200 mg) at 170ºC for 7 hours through the atomic absorption spectrophotometer. Many irrigated common bean genotypes presented high iron and zinc levels. The zinc contents for the samples showed superior to those related in literature. Iron levels ranged from 54,34 to 85,09 mg/kg while the zinc levels were between 32,44 and 57,82 mg/kg, with mean values of 70,19 and 44,28 mg/kg respectively. Some samples presented high levels of both minerals (e.g. HMN-67 and HMN-72) and are promising products for consumption. This experiment made possible to find higher sources of zinc in common beans, but it is still necessary to study other kinds of common beans with higher iron-content in order to reach the goal of the project. Several common bean genotypes studied presented high levels of iron and zinc under an irrigated system and with some samples a positive correlation was observed for both minerals.

TH25 BREEDING CASSAVA FOR ENHANCEMENT OF CAROTENOID IN THE BIOFORTIFICATION PROGRAM IN BRAZIL

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This work aimed towards the improvement of the nutritional quality of cassava varieties regarding carotenoid, Fe and Zn contents, inside the HarvestPlus program scenario. Initially, a total of 1800 cassava accessions, from the germplasm bank at Embrapa Cassava & Tropical Fruits, were screened. Total carotenoid contents in one-year old roots of the 72 landraces selected ranged from 0.63 to 15.51 µg.g-1 (fresh weight). However, it was detected that the accessions with higher carotenoid contents also presented elevated HCN levels. Thus, based on the low cyanogenic potential required for the consumption of boiled cassava roots (where carotenoid retention is higher), 7 landraces with carotenoid concentrations ranging from 1.50 to 4.49 µg.g-1 were selected as parents. In the first generation (228 genotypes), hybrids with a carotenoid increment of more than 100% in relation to the parents were identified. Carotenoid levels in the population ranged from 0.87 to 10.47 µg.g-1. Analyses of beta-carotenes revealed an approximated, but not linear, relation with the total carotenoid contents. In the second generation (136 hybrids), additional increment of carotenoid contents in relation to the first was verified, reaching the maxim concentration of 12.41 µg.g-1. Regarding Fe and Zn contents, the 72 yellow landraces initially selected, as well as all the hybrids of the two generations, were evaluated by atomic absorption. Keeping low HCN and high carotenoid concentrations as priority, hybrids with more than 10 µg.g-1 of carotenoids and with high levels of Zn and Fe were selected. These hybrids are currently under agronomical evaluations to be recommended as varieties.

Keywords: Manihot esculenta-Crantz, carotenoids, biofortification program

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TH26 DEVELOPMENT OF MAIZE CULTIVARS FOR HIGHER PRO-VITAMIN A CAROTENOIDS CONTENT IN BRAZIL

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HarvestPlus is a network of research institutes in Latin America, Asia, and Africa which seeks to enhance the nutritional quality of food containing iron, zinc, and pro-vitamin A. The conventional crossing of different varieties of corn, as also the identification and quantification of pro-vitamin A in these grains, have been the target of research by researchers at Embrapa Maize & Sorghum, through this biofortification program. In this sense, this work aimed to develop maize cultivars with higher pro-VA carotenoids content, inside the HarvestPlus program scenario. Two hundred forty-six (246) maize samples were screened for carotenoids profile. From this group, six inbred lines were selected for presenting higher total pro-VA content, ranging from 5.1 to 9.0 µg g-1 and averaged 6.6 µg g-1(fresh weight basis). These selected lines were used to develop a pro-VA synthetic variety. They were crossed to generate all hybrids combinations. Parental hybrids planted in the nursery field ranged from 4.0 to 11.4 µg g-1 and averaged 7.2 µg g-1 in total pro-VA content (fresh weight basis). As expected, these partial results indicated pro-VA carotenoids concentration for this synthetic in this environment to be 7.2 µg g-1 (fresh weight basis). These parental hybrids were crossed and the seeds bulked. The bulked seeds were planted in an isolated field. About 300 plants were selected based on agronomic traits and 50 ears were already screened for carotenoids profile. For total pro-VA, total carotenoids, transβ-carotene, β- criptoxanthin, Zeaxanthin and lutein, the average values for the 50 ears (µg g-1, dry weight basis) were 8.1, 30.8, 4.9, 3.6, 17.5, and 3.3, respectively, while, for the selected 10 ears, the average values were 10.1, 36.3, 6.4, 4.3, 20.2, and 3.7, respectively. A large degree of variation for carotenóides profile was observed. These partial results indicated the possibility for increasing simultaneously several components, such as total pro-VA, total carotenoids, transβ-carotene and β- criptoxanthin. The pro-VA averaged values for this synthetic is expected to significantly increase over the cycles of recurrent selection.

Keywords: Zea mays, carotenoids, biofortification, HarvestPlus