High-Iron and Zinc Rice Lines for Latin America

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Introduction

Micronutrient malnutrition, the result of diets poor in vitamins and minerals, affects more than half of the world's population. Women and children are especially susceptible to deficiencies in micronutrients, particularly vitamin A, iron and zinc. As a result they are at risk of disease, premature death, lower cognitive capacity, and poor quality of life. The costs of these deficiencies are high. In Latin America and the Caribbean (LAC) economic and health indicators have been deteriorating. To meet this challenge, the CGIAR is implementing a new paradigm that views agriculture as an instrument for improving human health and nutrition, as well as for increasing productivity. Nutritionally improved staple food provides an inexpensive, cost-effective, sustainable, long-term means of delivering micronutrients to the poor. The goal of the Biofortification Challenge Program (BCP) is to improve the health of the poor by breeding staple foods that are rich in iron, zinc and vitamin A, for poor consumers with priority on Africa and Asia. This program gets funding from diverse sources, including among others, The Melinda and Bill Gates Foundation.

A project funded by CIDA-Canada complements the Biofortification Challenge Program and extends its benefits to Latin America and the Caribbean, through the development of and deployment of high iron and zinc rice lines. Rice has become the most important food grain in LAC, supplying consumers with more calories than other staple crops. Rice has become particularly important in the diets of poor people, who make up about 40% of LAC's total population. Food purchases account for more than half of all expenditures by the poor, and rice accounts for about 15% of their food purchases. Among the poorest 20% of the population, rice supplies more protein to the diet than any other food source, including beef and milk. However, people living in several areas where rice consumption is high have been suffering from a number of major nutritional problems.

This is the result of vitamins and/or minerals naturally present in the rice grain but otherwise removed during the milling process (**Figures 1-2**) or that naturally are not present in sufficient amounts. Current research indicates that breeding is an efficient and trustable tool with a low cost to develop germplasm with a high nutritional value. Research carried out at IRRI (**Table 1**) in close collaboration with NARS suggests that there is genetic variability in the rice genome to increase Fe and Zinc in the rice grain. More recently, Haas *et al* (*J.Nutr.* 135:2823-2830,2005) reported that consumption of biofortified rice, without any other changes in diet, is efficacious in improving iron stores in women with iron-poor diets in the developing world. (**Figure 3**).

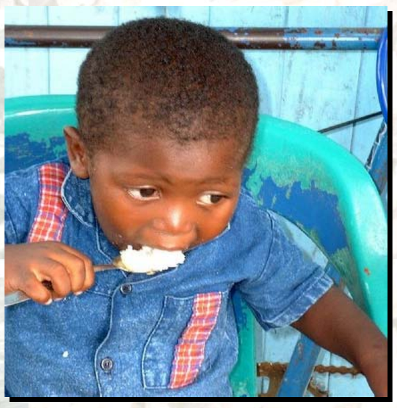
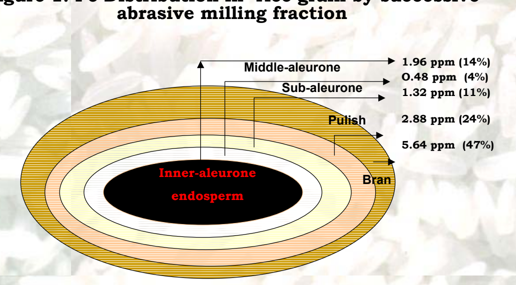


Figure 1. Fe Distribution in rice grain by successive abrasive milling fraction



Total Fe content 12 ppm

Resurreccion et al. 1978

Figure 2. Iron y Zinc content in rice brands bought by consumers in stores and supermarkets in Colombia.

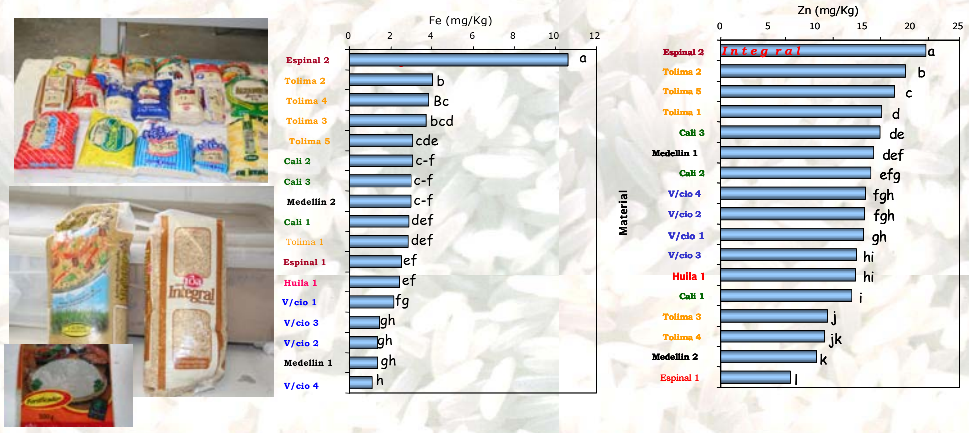
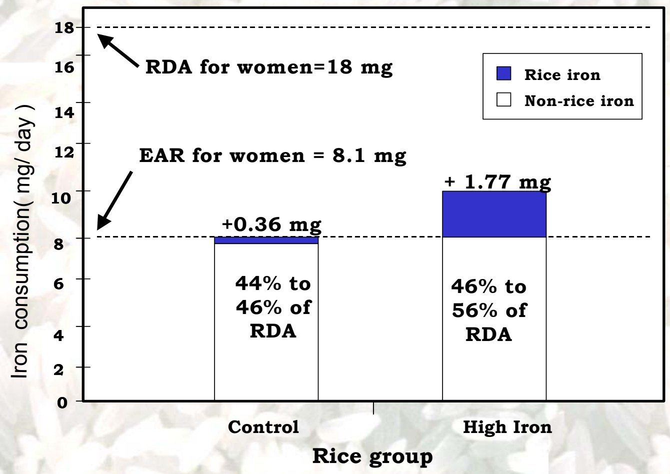


Table 1. Genetic Variability on Fe y Zn in Rice

	Sample No.	Fe (ppm)		Zn (ppm)	
		Range	Mean	Range	Mean
Commercial Varieties	40	8.8–16.3	11.3	19-36	23
Krosnodarshi (USSR)			16.3		36
Progenitors used in crossing	28	9.2–15.8	12.9	17-40	25
N22 (Nepal)			15.8		34
Traditional Varieties	42	9.0–21.0	12.9	14–36	27
• Padi Abang gogo (Indon)			21.0		35
• Payawa (Malaysia)			17.5		32
• IARC13168 (India)			17.1		34
• O19 (Nepal)			16.5		36
• Cavitenia (Phil)			16.3		18

Figure 3. Daily dietary iron intake from rice and non-rice sources for nonanemic women who consumed control or high-iron rice. Height of bars represent means, *n* = 69 for each group.



Eleven rice cultivars from the CIAT's germplasm bank were grown under irrigated conditions in Palmira, Valle and evaluated for its iron and zinc content based on atomic absorption techniques described by Isaac and Kerber(1971). Preliminary data indicated that on the average 59 and 26 % of the total iron and zinc present in brown rice is lost after milling. There were significant differences at the 5% level among genotypes tested in terms of milling losses and total content in polished rice.(**Tabla 2**).

Table 2. Effect of milling on grain iron and zinc content (ppm) in some selected rice cultivars. CIAT. 2002.

	IRON			ZINC		
Cultivar	Brown	Polished	% Milling loss	Brown	Polished	% Milling loss
Bg90 -2	7.2	5.1	*29.1*	17.3	13.9	*19.5*
O. barthii	10.4	4.2	*60.1*	27.9	22.0	*21.1*
CG -14	10.8	6.3	*41.3*	24.8	19.7	*20.4*
CT13956 -29-M-3-M	10.8	3.0	*72.1*	18.4	11.9	*35.3*
Fedearroz 50	14.0	4.8	*65.9*	25.6	16.7	*35.0*
IG10	12.3	3.7	*70.1*	24.8	18.1	*27.0*
O. glaberrima	30.4	3.6	*88.0*	25.0	19.2	*23.3*
Oryzica 1	13.5	6.1	*61.8*	16.5	11.0	*24.2*
Oryzica Llanos 4	13.0	4.9	*54.4*	20.8	15.7	*33.3*
P1274 -6-8-m-1-3	12.3	3.2	*74.2*	13.7	10.5	*23.3*
O. ruf ipogon	10.5	6.2	*41.3*	20.5	15.7	*23.6*
MEAN	**13.2**	**4.6**	***59.3***	**21.4**	**15.9**	***26.0***

In this project for LAC we plan to increase iron and zinc content in the rice grain using a breeding strategy in two phases. On a fast track, landraces and breeding lines conserved in the germplasm banks will be screen for mineral content to identify products that could have immediate utility, as potential varieties or donors. Meanwhile, a crossing program will be started to combine high-iron and zinc with high yield potential, tolerance to main biotic and abiotic stresses, and good grain quality. This project will be carried out in close partnership with research institutions in Colombia, Bolivia, Cuba, Brazil, Dominican Republic, and Nicaragua.

Conventional breeding techniques including the pedigree, bulk and backcrossing methods, as well as recurrent selection and induced mutations will he used. Emphasis will be made on the development, evaluation and selection of interspecific crosses.

Concluding Remarks

Recent studies indicate that plant breeding can play an important role in the development of nutritionally improved stapled foods such as rice. It has been shown that there is genetic variability available to increase the iron and zinc content in the rice grain. On the other hand, GxE interaction is important in the expression of Fe and Zn. To solve several challenges ahead a close and effective collaboration and partnerships among different disciplines, scientists and institutions is needed.

References

Isace, R.D. and J. D. Kerber. 1971. Atomic absorption and flamephotometry :techniques and uses in soil, plant and water analysis. *In* : L.M.Walsh (ed.) Instrumental methods for analysis of soils and plant tissue. SSSA, Madison, Wis.

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