Germplasm Identification and Development of Upland Rice Cultivars with High Zinc Contents

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INTRODUCTION

Rice (*Oryza sativa* L.) is cultivated all over Brazil. It is one of the major sources of calories and protein for Brazilian people with a *per capita* consumption of around 52 kg of paddy grain/year (FAOSTAT 2006). In 2005, upland rice varieties were cultivated on 2,502,338 ha that represent about 63.8% of the total rice growing area in Brazil. These upland varieties contributed to 37.2 % of the total 13,232,853 t of paddy rice with an average grain yield of 1,965 kg ha^{-1} (IBGE/CEPAGRO 2005). An equivalent area of 753,657 ha is cultivated with upland rice varieties in the Northeast region, mostly in small areas. This is essentially carried out by small farmers using mostly family labour. These small units are also characterized by a low level of technology input in a subsistence fashion. They yield around 19.3% of the national upland rice production (IBGE/CEPAGRO 2005). Moreover, the Northeast region is where undernourishment mostly affects children in Brazil. The objective of this work was to provide good quality seeds to small farmers of Northeast Brazil with varieties that have a high Zn content. Herewith, sustained seed production in partnership with farmers would be assured and, in the long run, bio-fortified products could be distributed to poor farmers and their families as well as consumers.

METHODS

To identify rice sources with high Zn contents, we used the Brazilian rice germplasm comprising local varieties, improved/recommended cultivars and improved lines from 'Embrapa Rice and Beans' in addition to improved lines introduced from CIAT. Around 231 rice accessions were multiplied in Goiania (2004/2005), and the improved Embrapa lines were planted on 5 different sites. After harvesting, the rice was sent to the Grain Quality Lab located at 'Embrapa Rice and Beans', where, so far, Zn levels of 97 materials have been determined to detect those with higher levels. The Zn content was analyzed after nitric-perchloric acid digestion (2:1) of milled brown and polished rice samples using an Atomic Absorption Spectrophotometer (AAS) (Varian) according to AOAC (1995) methods 9.1.01 and 9.1.06 with some modifications.

RESULTS AND DISCUSSION

The distribution of Zn contents of analyzed brown and polished rice samples is shown in Fig. 1. The 97 rice accessions showed a normal distribution of Zn content. Brown rice is composed of parts that are considerably different in nutritional value. Brown rice also has a superior composition when compared to polished rice because of the nutrient losses that occur during processing. However, a big difference between brown and polished rice was not noticed suggesting that this mineral is more concentrated in the internal layers of the grain

endosperm. In Fig. 1, the variation of Zn content in brown (1a) and polished rice (1b) can be seen. Ranges of Zn from 4.1 to 18 ppm for polished rice and 5.2 to 22 ppm for brown rice were observed. The average values were 9.89 and 15.08 ppm for polished and brown rice, respectively. Around 37% of the polished samples had Zn levels above 12 ppm, and 44% of brown rice had Zn contents above 15 ppm. From these superior materials of polished and brown rice, 32 and 11.5% are from recommended cultivars, 16 and 7.7% are from CIAT, 52 and 80.8% are from 'Embrapa Rice and Beans' improved lines, respectively. Around 50% of Zn was lost after rice polishing. Our preliminary results are in accordance with literature data (Philippi 2002).

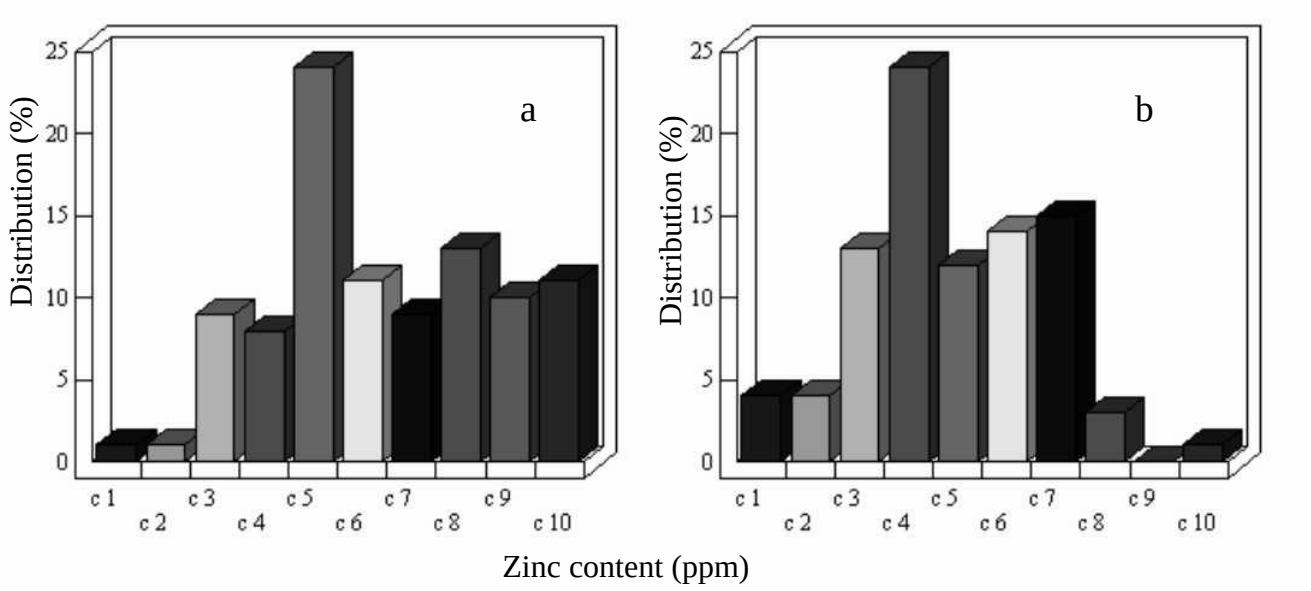

Fig. 1. Distribution of Zn contents in rice samples (a: brown rice, b: polished rice). The letters c1, c2, c3, c4, c5, c6, c7, c 8, c9 and c10 on the X-axis indicate the Zn concentration (ppm) range: Fig. 1a: 5.2 –6.88, 6.88 –8.56, 8.56 –10.24, 10.24 –11.92, 11.92 –13.6, 13.6 –15.28, 15.28 –16.96, 16.96 –18.64, 18.64 –20.32, 20.32 –22; Fig. 1b: 4.1 –5.48, 5.48 –6.86, 6.86 –8.24, 8.24 –9.62, 9.62 –11.0, 11.0 –12.38, 12.38 –13.76, 13.76 –15.14, 15.14 –16.52, 16.52 –17.9, respectively.

CONCLUSIONS

Considering the rice samples that have been evaluated so far, it can be concluded that there is variability in Zn content. A breeding program for this trait could be started. It is necessary to continue looking for sources richer in this mineral.

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