HarvestPlus
ABSTRACT No.4

Iron Biofortified Rice Improves the Iron Stores of Non-Anemic Filipino Women

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Iron deficiency is the most prevalent nutritional deficiency in the world affecting an estimated 3.5 billion people. Among the most at risk in developing countries, are women of reproductive age. Strategies to alleviate the problem are public education to improve diets, supplementation, and iron fortification of the food supply. Biofortification of staple food crops is a new approach to complement existing interventions. Developing staple food crops with substantial amounts of micronutrients such as iron, zinc, and pro-vitamin A through conventional breeding and biotechnology has the potential to significantly improve nutritional status of vulnerable groups. In processed and cooked form, biofortified high iron rice developed through conventional breeding at the International Rice Research Institute has four to five times more iron than commercially available rice. Sensory evaluation prior to the feeding study showed that high-iron rice was comparable with the commercial rice.

The feeding study with 317 religious sisters from 10 Roman Catholic convents in the Philippines, aimed to test the biological effects of consuming the biofortified high-iron rice in a prospective, randomized, controlled, double-blind experimental design. Low-iron commercial rice and the biofortified high-iron rice were randomly assigned to the women, who were stratified into two groups based on their baseline ferritin (Ft) and hemoglobin (Hb) levels. Sample size was calculated at 60 per group based on estimated increase of serum Ft of 9 ug/L or 1.5 SD for the population. Three representative samples of cooked rice were collected bi-weekly for 9 months to monitor iron content. Rice portions from each meal were weighed together with the entire diet, on three randomly assigned days every two weeks for a total of 56 daily food intake measurements. Physical activity of subjects was monitored with a self-administered weekly activity form. Venous blood samples were collected at baseline, midpoint, and at endpoint (9 months).

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Baseline measurement of Hb showed 31 percent of the control group and 25 percent of the high iron group were anemic (Hb <120 g/L), while 32 percent of the control group and 25 percent of the high iron group were iron deficient based on Ft values less than 12 μg/L. Rice consumption of 600 g/d provided an average of 53 percent of total energy intake. There was a significant difference in iron content between the high-iron rice (3.21 mg/kg) and the control rice (0.57 mg/kg). The biofortified high-iron rice provided an additional 1.41 mg/d of iron to the diet, resulting to an 83 percent difference of iron content between the two rices. Subjects assigned to the biofortified high iron rice group consumed 0.11 mg/d more iron from meat than the control group. However, meat intake did not have a significant effect on change in iron status. Dietary iron intake from food other than rice was 8.0 mg/d or 45 percent of the US Food and Nutrition Board recommended dietary allowance (RDA). Biofortified high-iron rice provided 1.77 mg/d of iron and accounts for 10 percent of the RDA. While 50% of the control group consumed sufficient dietary iron to meet their Estimate Average Requirement (EAR) for iron, 72% of the high iron group achieved their EAR. Final hemoglobin values did not differ between groups, probably because much of the anemia in this population is caused by factors other than iron deficiency. However, in non-anemic subjects significant improvements were observed in Ft and total body iron in the high iron rice group. The biofortified rice benefited iron-deficient subjects in terms of increasing their iron stores. It also benefited the non-deficient subjects by allowing them to maintain their normal iron stores. Also, there was a significant positive correlation between iron intake from rice and change in serum Ft ($r = 0.31$; $P<0.01$) for the duration of the study. Although this study tested the benefits of additional iron in replenishing the iron stores of non-anemic women, it is reasonable to assume that significant benefits would accrue to anemic women as well, if their anemia is the result of iron deficiency. Also, while consumption of the high-iron rice reduced the gap between typical iron intake and iron sufficiency, it did not eliminate the gap. That may be an unrealistic expectation, given the limited potential for increasing iron content of rice through conventional selective breeding. However, by closing the gap between normal iron intake and sufficiency, this study suggests that about 20% of women who had marginally insufficient iron intakes would have crossed the threshold to sufficiency. This feeding trial thus provides encouragement that the breeding strategy promoted by HarvestPlus has the potential to improve the diets of the poor in developing countries.

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