



## Efficacy and Other Nutrition Evidence for Zinc Crops

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After plant breeders have successfully developed varieties of selected staple foods to increase the zinc (Zn) content, the foods must be tested for a number of qualities before they can be considered for introduction into the food supply. Efficacy, or the demonstration of a significant impact on the nutritional status of human subjects who consume the staple food under controlled experimental conditions, must be demonstrated. Efficacy studies are planned for biofortified wheat and rice in 2014 and 2015.

**Zinc-biofortified Wheat:** Rosado et al. carried out a trial comparing zinc absorption from biofortified versus conventional wheat as 95 and 80% extraction flours (1). Adult women consumed 300 g of each type of the high- and low-extraction flours as tortillas for two consecutive days using either biofortified (41 mg Zn/g) or control (24 mg Zn/g) wheat. Mean ( $\pm$  SD) total zinc absorption from biofortified wheat was  $2.1 \pm 0.7$  mg/d and  $2.0 \pm 0.4$  mg/d for 95 and 80% extraction, respectively; each of which was 0.5 mg/d higher than the corresponding control ( $p < 0.05$ ). The authors concluded that “potentially valuable increases in zinc absorption can be achieved from biofortification of wheat with zinc.” In 2013, a zinc absorption trial was conducted in Switzerland with the same type of wheat flour produced for the future efficacy trials. Results will be published in 2014.

Two efficacy trials using biofortified wheat will be conducted in India in 2014, one among school children in Bangalore by the Swiss Federal Institute of Technology (ETH-Zurich) and another among preschoolers and their mothers in the rural slum areas of New Delhi by Cornell University.

**Zinc-biofortified Rice:** A 2010 zinc bioavailability pilot trial, designed to estimate the amount of zinc absorbed from zinc rice and compare that with absorption from conventional rice using the triple stable isotope tracer ratio technique, failed to produce detectable differences in absorbed zinc (2). High phytate and lower-than-expected zinc in the biofortified zinc variety resulted in no significant difference in absorption between groups. The study was redesigned with a prospective biofortified variety containing more than 10 ppm zinc and comparable phytate concentration with that of the control. In September 2013, rice varieties with a 12 ppm differential were selected, and the absorption trial planned accordingly. The study is expected to be completed by September 2014. An efficacy study will follow.

Other indirect evidence is available for zinc. Although pearl millet is considered by HarvestPlus to be primarily an iron-biofortified crop, it provides some useful evidence regarding zinc biofortification. In their recent study comparing biofortified and conventional pearl millet in young children in India, Kodkany et al. showed that the quantities of zinc absorbed from test and control groups were  $0.95 \pm 0.47$  mg/d and  $0.67 \pm 0.24$  mg/d, respectively ( $p = 0.03$ ) (3). The authors concluded that the quantities absorbed from the biofortified pearl millet were more than adequate to meet the physiological requirements for zinc in children age 2 years. Those results contribute to the accumulating evidence that zinc biofortification can be successful.

Results from ongoing or planned controlled efficacy studies using zinc-biofortified foods will provide further proof of concept. Lowering phytate levels could increase the bioavailability and potential for efficacy and effectiveness of zinc crops.

### Challenges:

- HarvestPlus convened an expert consultation in 2012 to review the normative physiological zinc requirements, which concluded that the reference value for adult women used to set the original zinc breeding targets (1.86 mg/d) had to be revised up to 2.5–2.9 mg/d to conform to current evidence on the subject. This increase in physiologic requirements resulted in the breeding target for wheat and rice being raised to +12 ppm above baseline, which will contribute around 20% of the zinc EAR for a woman of childbearing age.
- For zinc biofortified crops, it is recommended that lower phytate levels also be included in the traits pursued by plant breeders in order to increase bioavailability and biological impact in vulnerable population groups.

1. Rosado, J; et al. 2009. The quantity of zinc absorbed from wheat in adult women is enhanced by biofortification. *Journal of Nutrition* 139:1920–1925.
2. Islam, MM; et al. 2013. Total zinc absorption from a diet containing either conventional rice or higher-zinc rice does not differ among Bangladeshi preschool children. *Journal of Nutrition* 143:519–525.
3. Kodkany, BS; et al. 2013. Biofortification of pearl millet with iron and zinc in a randomized controlled trial increases absorption of these minerals above physiologic requirements in young children. *Journal of Nutrition* 143:1489–1493.