

The Role of Bio-Fortified Rice to Eradicate Hidden Hunger

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SUMMARY

Rice is a poor source of essential micronutrients such as Fe and Zn. The micronutrient malnutrition, and particularly Fe and Zn deficiency affect over three billion people worldwide, mostly in developing countries. Therefore, increasing iron and zinc content in rice is a viable option in alleviation of micronutrient malnutrition. In addition to this, bio fortified seeds produce rapid seedlings growth initially and more seedlings ultimately leading to higher yields particularly in the trace mineral deficient soils in arid regions. The mineral packed seeds help the poor farmers in reducing the cost of cultivation as the elements help plants to resist diseases and other environmental stresses.

INTRODUCTION

Green revolution has helped in increasing the food production, thereby greatly reduced starvation, calories and protein malnutrition. However, this caused greater depletion of micronutrient reserve in soil and thereby accentuated wide spread deficiencies of micronutrients. Malnutrition is a social evil, especially in the developing and underdeveloped nations.



What is Hidden Hunger?



Iron (Fe) is an essential element for blood production, about 70 *per cent* of the body's iron is found in the red blood cells called hemoglobin. The hemoglobin is essential for transferring of oxygen from the lungs to the tissues. About six *per cent* of body's iron is a component of certain proteins, essential for respiration and energy metabolism and as a component of enzymes involved in the synthesis of collagen and some neurotransmitters while deficiency of iron leads to anemia. Zinc (Zn) being an important mineral, plays a vital role in protein synthesis and helps regulate immune system of the human body. The health benefits of zinc include a proper functioning of the immune and digestive systems, controlled diabetes, reduction in stress levels, improved metabolism and an increased rate of healing of wounds. Also, it is helpful in terms of pregnancy, hair care, night blindness, cold, eye care, appetite loss and many other condition.

What is Hidden Hunger?

The iron and zinc deficiency leads to crop yield losses as well as human health problems. Micronutrient deficiency is the fifth major global challenge to human health. Iron and zinc deficiency is the most common and widespread, afflicting more than half of the human population (WHO, 2009). The worst hit are the developing countries of Asia and Africa (Gómez-Galera *et al.*, 2010). More than two billion people suffer from iron deficiency alone, and the estimates of zinc deficiency are also close (Thacher *et al.*, 2006). Deficiency of iron and zinc, also known as 'Hidden hunger', results in poor growth and compromised psychomotor development of children, reduced immunity, fatigue, irritability, weakness, hair loss, wasting of muscles, sterility, morbidity and even death in acute cases.

Causes for Hidden Hunger

This situation is largely attributed to the high consumption of cereal based foods, rice, wheat and maize. Edible parts (endosperms) of modern cereal cultivars are inherently poor in iron and zinc concentration in whole grain. One of the major reasons for their low accumulation in edible parts is the cultivation of cereals on zinc-deficient soils, particularly in developing countries like India (Alloway, 2009). The Green Revolution is also considered to have contributed to the prevalence of these micronutrient deficiencies in soils because it promoted the use of high-yielding varieties, large-scale irrigation and macronutrient fertilizers. It is considered that high yielding varieties led to the dilution effect of micronutrients due to increased 1000 kernel weight. The existence of a negative relationship between irrigation and iron and zinc uptake and a similar negative relationship between phosphorus and iron and zinc uptake (Saha *et al.*, 2013) also lead to lower the accumulation of these micronutrients in the grains. Since the edible parts of the cereals and pulses are poor in iron and zinc, thus heavy dependence of people from developing countries on these foods results in the development of large-scale iron and zinc malnutrition.

How to Tackle Hidden Hunger

To alleviate iron and zinc deficiency, breeding rice varieties with high grain Fe and Zn has been suggested to be a sustainable, targeted, food-based and cost effective approach in alleviating Fe and Zn deficiency. The physiological, genetic and molecular mechanisms of Fe and Zn homeostasis have been well studied, but these mechanisms need to be characterized from a biofortification perspective and should be well integrated with the breeding processes. There is a significant variation for grain Fe and Zn in rice germplasm and efforts are being directed at exploiting this variation through breeding to develop high Fe and Zn rice varieties. Several QTLs and gene specific markers have been identified for grain Fe and Zn and there is a great potential to use them in Marker-Assisted Breeding. A thorough characterization of genotype and environmental interactions is essential to identify key environmental factors influencing grain Fe and Zn. Agronomic biofortification has shown inconsistent results, but a combination of genetic and agronomic biofortification strategies are more effective. Significant progress has been made in developing high Fe and Zn rice lines for release in target countries. A holistic breeding approach involving high Fe and Zn trait development, product testing and release, including bioefficacy and bioavailability studies is essential for successful Fe and Zn biofortification.



CONCLUSION

Previous studies indicated that growing crops with high seed zinc resulted in better seedling vigour and seed viability, higher yield and lessening of seed rate required for sowing, especially on potentially zinc deficient soils (Rengel, 2002 and Cakmak, 2008). Thus, enrichment of seeds with iron and zinc could provide a practical approach for alleviating the micronutrient deficiency problem, especially when farmers are not aware of zinc and iron deficiency *vis-a-vis* to improve the health of the consumers, especially those whose iron and zinc intake comes primarily from cereal grains.

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