The Feasibility of Using Zinc Fertilizers to Improve the Adequacy of Zinc Intakes of Children Consuming Rice-Based Diets in NE Thailand

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INTRODUCTION

Rice is the major cereal staple in Thailand, often contributing to more than 70% of the total energy in the diets of young children. Rice is a crop that is highly sensitive to Zn-deficient soils, which are found in the semi-arid Northeast region of Thailand. Rice grown locally on these low-Zn soils will be low in Zn, thus compromising the Zn intake of young children. This is unfortunate because inadequate Zn intake of this age group can lead to impairments in growth and immune function, which may in turn increase susceptibility to infectious illnesses and the risk of mortality.

Zinc fertilizers are often used by farmers to correct Zn deficiency in Zn-deficient soils. This practice does enhance yield and Zn uptake in rice and, hence, has the potential to increase Zn intake in children. Therefore, we calculated the theoretical increase in Zn intake that could be expected in children through the application of Zn fertilizer to low-Zn soils used to grow rice in NE Thailand. Secondly, we assessed if such increases in Zn intakes are likely to provide absorbed Zn that is sufficient to reduce the prevalence of Zn deficiency among children in NE Thailand.

METHODS

Details of the subjects and methods have been described elsewhere (Krittaphol et al. 2006). Briefly, 567 NE Thai children from Trakarn Phutphon, Ubon Ratchathnai province participated in a randomized, controlled trial (RCT) of a fortified seasoning mix. Serum Zn and C-reactive protein concentrations were assayed at baseline and at the end of the RCT by Atomic absorption spectroscopy (AAS). One-day weighed food records were completed by their primary caregiver on a random subset of children (40 M; 40 F, aged 6 to13y). All week days were equally represented. Zinc and phytate (Phy) intake and Phy:Zn molar ratios were calculated before and after a theoretical soil fertilizer treatment containing 15 kg Zn/hectare. The latter was assumed to increase the Zn content of rice grains by 43% based on data from low Zn-soils in Pakistan (Umar Khan et al. 2002). An enhanced Thai nutrient composition database was used, based on analyzed Zn and phytate values for 12 local staples purchased from local markets and vendors, literature data, and the Thai Food Composition database.

RESULTS AND DISCUSSION

Table 1. Mean (±SD) Zn and phytate intakes and Phy:Zn molar ratios of diets of NE Thai children pre- and post-application of Zn fertilizer to soil (mg/d).

Dietary variable	Pre-treatment	Post-treatment
Zn (mg/d)	4.8 ± 1.8	8.6
Phytate (mg/d)	165 ± 123	165 ± 123
Phy:Zn molar ratio	3.1	1.8

The mean Zn intake of the NE Thai children pre-treatment group (Table 1) was low. However, the intake of phytate, a potent inhibitor of Zn absorption, and the Phy:Zn molar ratios were both low, which is attributed in part to the loss of water soluble Na or K phytate from glutinous rice after soaking overnight prior to steaming. Hence, Zn absorption would not be compromised by phytate in these rice-based diets. Nevertheless, the mean serum Zn concentration of the 80 subjects was 9.42 µmol/L, much less than the U.S NHANES II 50th percentile for this age group (Hotz et al. 2003). Furthermore, 72% of these children had low serum Zn values indicative of Zn deficiency and suggesting that the dietary Zn intake was inadequate.

The mean theoretical Zn intake nearly doubled for the post-treatment group (Table 1). Fortuitously, this level of improvement in Zn intake approximated the additional Zn (i.e., 3.75 mg/d) contributed by the Zn-fortified seasoning powder in one school lunch, after taking into account the median portion size of lunch actually consumed by the school children during the RCT. Furthermore, consumption of the fortified seasoning powder in the RCT significantly reduced the prevalence of low serum Zn concentrations in the fortified compared to the unfortified group, post-intervention ($p=0.024$) (Winichagoon et al. 2006).

These findings suggest that additional Zn derived from rice grown on soils treated with a Zn fertilizer could get absorbed and be potentially at a level that reduces the prevalence of Zn deficiency and its associated adverse health outcomes amongst NE Thai school children.

CONCLUSIONS

The increase in Zn intake that is likely to be achieved through the use of Zn fertilizer on low-Zn rice-growing soils in NE Thailand has the potential to reduce Zn deficiency and to improve growth and immune function in NE Thai school children.

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