

Bioavailability of Zinc to Wheat Grown in the Calcareous Soils of Iraqi Kurdistan

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Abstract : Knowledge of the zinc and phytic acid (PA) concentrations of staple cereal crops are essential when evaluating the nutritional health of national and regional populations. In the present study, a total of 120 farmers' fields in Iraqi Kurdistan were surveyed for zinc status in soil and wheat grain samples; wheat is the staple carbohydrate source in the region. Soils were analysed for total concentrations of phosphorus (PT) and zinc (ZnT), available P (POlsen) and Zn (ZnDTPA) and for pH. Average values (mg kg⁻¹) ranged between 403-3740 (PT), 42.0-203 (ZnT), 2.13-28.1 (POlsen) and 0.14-5.23 (ZnDTPA); pH was in the range 7.46-8.67. The concentrations of Zn, PA/Zn molar ratio and estimated Zn bioavailability were also determined in wheat grain. The ranges of Zn and PA concentrations (mg kg⁻¹) were 12.3-63.2 and 5400 - 9300, respectively, giving a PA/Zn molar ratio of 15.7-30.6. A trivariate model was used to estimate intake of bioaccessible Zn, employing the following parameter values: (i) maximum Zn absorption = 0.09 (AMAX), (ii) equilibrium dissociation constant of zinc-receptor binding reaction = 0.680 (KP), and (iii) equilibrium dissociation constant of Zn-PA binding reaction = 0.033 (KR). In the model, total daily absorbed Zn (TAZ) (mg d⁻¹) as a function of total daily nutritional PA (mmole d⁻¹) and total daily nutritional Zn (mmole Zn d⁻¹) was estimated assuming an average wheat flour consumption of 300 g day⁻¹ in the region. Consideration of the PA and Zn intake suggest only 21.5±2.9% of grain Zn is bioavailable so that the effective Zn intake from wheat is only 1.84-2.63 mg d⁻¹ for the local population. Overall results suggest available dietary Zn is below recommended levels (11 mg d⁻¹), partly due to low uptake by wheat but also due to the presence of large concentrations of PA in wheat grains. A crop breeding program combined with enhanced agronomic management methods is needed to enhance both Zn uptake and bioavailability in grains of cultivated wheat types.

Keywords : phosphorus, zinc, phytic acid, phytic acid to zinc molar ratio, zinc bioavailability

Conference Title : ICFQMI 2018 : International Conference on Food Quality, Micronutrients and Ingredients

Conference Location : Zurich, Switzerland

Conference Dates : September 13-14, 2018