Zinc (Zn) in Biofortified Crops: Efficacy in Human Nutrition

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INTRODUCTION

In recognition of the unfavorable intakes of Zn from diets worldwide that are limited primarily or entirely to plant foods, major efforts are currently in progress to enhance the Zn content of cereal grains and legumes either by selective plant breeding or/and by increasing the quantity of available Zn in soils. With plant selection/breeding techniques, initial quantities of high-Zn crops are likely to be limited. However, the yield from pilot crops would be more than sufficient for measurement of Zn absorption from total diets based on these crops in first stage, economically feasible, efficacy studies. An example of such a study, utilizing Zn stable isotope techniques, is currently in progress in adult women to determine the quantity of Zn absorbed from a high-Zn wheat. Preliminary data from this study will be presented. Meanwhile the results of this study were predicted based on results of measurements of Zn and phytate concentrations in the wheat.

METHODS

Predictions of the quantity of Zn absorbed from a high-Zn versus control wheat flour were derived from the application of a trivariate saturation response model that allows calculation of the quantity of absorbed Zn as a function of dietary Zn and phytate (Miller et al. 2006). The predictions are based on the consumption of 300g wheat flour, a representative quantity for women in populations that depend on wheat as the major food staple, and on two levels of extraction. Concentrations of Zn and phytate in the two grains and in 95% and 80% extracted wheat flour are given in Table 1.

Table 1. Zinc and phytate concentration in high-Zn and control wheat grain and flour.

Extraction	Wheat	[Zn] ug/g	[Phy] mg/g
Whole Grain	Control	23.6	8.9
	High Zn	41.3	11.1
High (95%)	Control	23.0	9.0
	High Zn	40.5	9.3
Low (80%)	Control	14.4	3.4
	High Zn	23.8	3.3

The quantities of Zn and phytate in 300g wheat and phytate:Zn molar ratios are given in Table 2.

Table 2. Zinc and phytate content and phytate:Zn molar ratios in 300 g high-Zn and control wheat flour.

Extraction	Wheat Flour	mg Zn/ 300 g	mg Phy/ 300 g	Phy:Zn
High (95%)	Control	6.9	2700	39:1
	High Zn	12.2	2790	23:1
Low (80%)	Control	4.3	1020	23:1
	High Zn	7.1	990	14:1

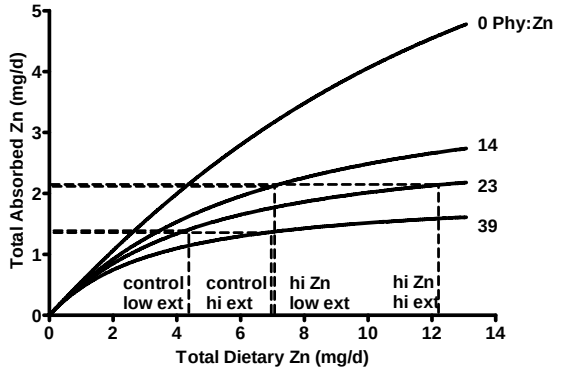

Fig. 1.

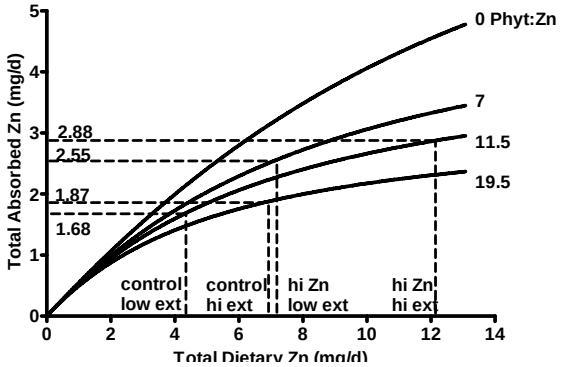

Fig. 2.

Figure 1 is a 2-D plot derived from the trivariate model that includes saturation response curves for zero phytate and for the levels of phytate in 300g wheat at two levels of extraction. Zinc intakes from 300g wheat flour are plotted on the x-axis, and vertical lines from these points intersect the corresponding phytate curve. Horizontal lines from this intersect to the y-axis gives the predicted absorption. Figure 2 is the corresponding plot for 50% phytate reduction.

CONCLUSIONS

1) The reduction in Zn with 80% extraction is offset by the reduction in phytate, so that the predicted Zn absorption from either high-Zn or control wheat is not diminished.

2) Zn absorption from the high-Zn wheat is >50% greater than that from the control wheat, but the quantity absorbed from 300g wheat flour at either 95% or 80% extraction does not attain the estimated average Zn requirement for adult women of 3.3mg Zn/d (Food and Nutrition Board 2001). Estimated average Zn requirements are, however, approached if, in addition, there is moderate pre- or post-harvest phytate reduction beyond that achieved with extraction. Confirmation of the accuracy of predictions applying this trivariate model with stable isotope studies of Zn absorption in different population groups may ultimately allow use of this or other models alone to predict absorption with sufficient accuracy.

ACKNOWLEDGEMENTS

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REFERENCES

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