Improving Zinc Delivery by Sorghum to its Consumers. Interventions along the Food Chain

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INTRODUCTION

In micronutrient malnutrition, Zn is second in importance only to Fe. Over the past years, large international efforts have been made to seek for breeding options to biofortify major staple crops with Zn and Fe and vitamine A (Welch and Graham 2004). In addition, the here reported program was designed to quantify the contribution of either single interventions in agronomy and food processing or combined interventions in both areas on Zn delivery by the sorghum food chain in West Africa.

METHODS

A conceptual framework (Fig. 1) was developed to direct research on different stages along the food chain and to integrate results of component studies towards the end of the program. Individual studies focussed on the 1) existing genetic variation in the sorghum germplasm, 2) options to improve crop Zn uptake and grain loading through soil fertility management, 3) effects of phytate and polyphenolics on bioavailability of Zn, 4) role of sorghum in total Zn intake by humans and 5) contribution of food preparation methods to Zn bioavailability for humans. Targeted studies in the final stage of the program help to link components and seek for interactions determining total chain performance.

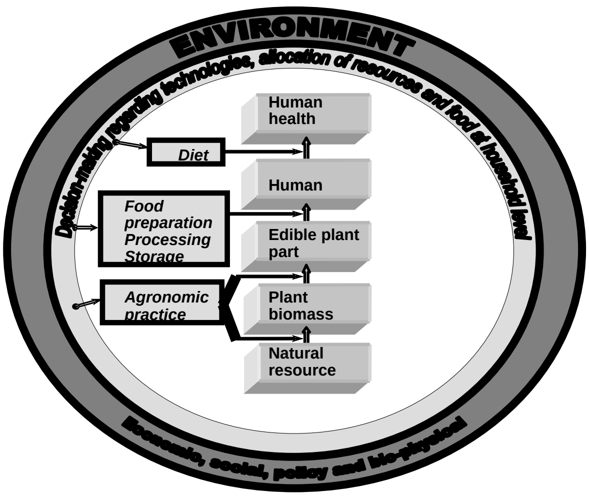

Fig. 1. Graphical representation of the framework used to direct and integrate the presented research program.

RESULTS AND DISCUSSION

Grain Zn, Fe and phytate mass fractions differed between the tested varieties (Table 1). For Zn, a five-fold difference was observed indicating that breeding is an option to increase grain Zn mass fractions (ZnMF) in this crop, as it seems to be in a number of others.

Table 1. Observed averages and ranges for zinc, iron and phytate mass fractions in the grains of 200 tested sorghum accessions.

	Grain mass fractions (mg/kg)		
	Zn	**Fe**	**Phytate**
Average	**26**	**48**	**1280**
Range	**10-51**	**15-98**	**380-3260**

Improved nutrient and organic matter management resulted in a three-fold increase in grain ZnMF (Traore 2006). Both P and Zn fertilizer improved grain production and grain ZnMF, although Zn was more effective in increasing grain Zn, and P was more effective in increasing yield. The effects of both types of fertilizer were largely additive. Improved grain ZnMF were accompanied by enhanced grain phytate levels. The anti-nutritional effect of phytate implies that total Zn delivery with improved plant nutrition can only be guaranteed if the phytate can be handled later on in the food chain. Given the large effects of both genetic differences and induced environmental differences on grain Zn mass fractions, follow-up studies to study genotype by environment interactions are envisaged.

The food processing studies (Kayodé 2006) highlighted the role of phytate and polyphenolics in *in vitro* solubility (IVS) of Zn. IVS as well as molar ratios of phytate and Zn have been proposed as proxies of bioavailability of Zn to the human consumer. There were differences in IVS and phytate/Zn molar ratios in sorghum foods like porridges among preparation protocols. Milling could improve bioavailability, but no conclusive data are available. Work on Fe to relate phytate/Fe molar ratios and IVS with gut uptake as simulated with Caco-2 cells indicated that the two former indicators of bioavailability may not show the whole picture stressing the need for further work on reliable indicators of micronutrient bioavailability.

As a next step in improving the production chain, studies are underway to check how effective improved crop production methods and preparation methods can be combined to improve Zn bioavailability in the food matrix after processing.

CONCLUSIONS

The developed framework has been very effective in both providing directives for the individual studies from the start of the research program and in linking the studies while these were conducted. Some additional work is still underway to study whether all observed effects of individual chain components are additional or whether there are positive or negative interactions. Part of this work will be available for presentation during the conference.

ACKNOWLEDGEMENTS

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