Research Application Summary

Potential sources of high iron and zinc content in Ugandan bean germplasm

Mukamuhirwa, F.[1], Tusiime, G.[1], Mukankusi, C. [2], Gibson, P. [1] & Edema, R.[1]
[1]Department of Agricultural Production, Makerere University, P. O. Box 7062, Kampala, Uganda
[2]CIAT Africa, National Agricultural Research Laboratories -Kawanda, P. O. Box 7065, Kampala, Uganda
Corresponding author: fmukamuhirwa@yahoo.com

Abstract

The study was conducted at National Agricultural Research Laboratories (NARL) at Kawanda in order to identify potential sources of high iron and zinc content, Such varieties would contribute to improved health of bean *(Phaseolus vulgaris)* consumers, who, despite a high consumption of beans, suffer from anemia caused by micronutrient malnutrition (especially iron and zinc). One hundred and eighty seven genotypes from Uganda were screened for iron (Fe) and zinc (Zn) content. The mineral analysis revealed that there was significant (P=0.001) diversity in Fe and Zn content among the Ugandan genotypes with the range of 45 to 87mg/kg of iron and 22 to 40 mg/kg of zinc. Ten Ugandan bean varieties were identified as potential sources of both high iron and zinc content.

Key words: Anemia, health, bio-fortification, iron, micronutrient malnutrition, *Phaseolus vulgaris*, zinc

Résumé

L'étude a été menée dans les Laboratoire National de Recherche en Agronomie (NARL) à Kawanda afin d'identifier les sources potentielles de la haute teneur en fer et en zinc ; Ces variétés contribueraient à améliorer la santé des consommateurs de haricot (*Phaseolus vulgaris*), qui, malgré une consommation élevée de haricots, souffrent d'anémie causée par la carence en micronutriments (en particulier le fer et le zinc). Cent quatre vingt sept génotypes de l'Ouganda ont été projetés pour la teneur en fer (Fe) et en zinc (Zn). L'analyse minérale a révélé qu'il y avait une diversité significative (P = 0,001) dans la teneur en Fe et en Zn entre les génotypes ougandais avec la gamme de 45 à 87mg/kg de fer et 22 à 40 mg / kg de zinc. Dix variétés de haricots ougandais ont été identifiées comme des sources potentielles à la fois de la teneur en fer et en zinc.

Mots clés: Anémie, santé, bio-fortification, fer, carences en micronutriments, *Phaseolus vulgaris*, zinc

Background

Micronutrient malnutrition has disastrous consequences for the more vulnerable members of the human society, especially poor women and pre-school children in developing countries (Hoppe, 2005). The Recommended Dietary Allowances (RDAs) for healthy nutrition of adults is 13mg for zinc and 27mg for iron (Institute of Medicine, 2001). In Rwanda and Uganda, Fe and Zn are among the most limiting micronutrients in the diets of the rural- and urban- poor with Fe difficiency resulting in anemia and Zn difficiency resulting in depressed immune function. The most affordable way of combating Fe and Zn malnutrition in this category of people is to consume foods rich in the micronutrients (HarvestPlus, 2011). While a varied diet is the ideal solution, dietary changes usually do not occur quickly, especially among the poor. In such cases, biofortification of foods typically consumed in large quantities is a partial solution. Some common bean (*Phaseolus vulgaris*) varieties contain high levels of Fe and Zn and therefore can provide a cheap source of these micronutrients. Unfortunately, the levels of these micronutrients in most adapted bean and market class varieties is not known in Uganda (HarvestPlus, Unpublished Data, 2011). The main objective of this study was to identify genotypes with high Fe and Zn seed content among Ugandan bean genotypes for fast tracking and breeding purposes.

Literature Summary

The common bean (*Phaseolis vulgaris*) is an important source of protein and minerals. It can supply all the iron that humans require for metabolism and provides 25% of the daily requirements of magnesium and copper as well as 15% of potassium and zinc. In nutritional terms, beans are often called the "poor man's meat" for their inexpensive price as a protein source and their rich content of minerals, especially iron and zinc, and vitamins (Beebe, 2000). According to Uganda Bureau of Statistics, 2010, out of 929,000 metric tones of bean produced in 2008- 2009, 31.6% was sold, 32.4% was consumed 23.5% was stored and 12.5% was used for other purposes. Given its central role in the country' s economy, enhancement in the utilisation of common bean genetic resources could go a long way in eradicating extreme poverty, hunger and malnutrition among the population, hence contributing greatly to achieving the United Nations number one Millennium Development Goal (Bua, 2010). Nutritious beans can therefore be a sustainable method to deliver micronutrients to reduce malnutrition using familiar foods especially in rural areas, where about 75% of the poor live, and where they have limited access to supplements, commercially marketed fortified foods, or other urban-based interventions (HarvestPlus, 2011).

Study Description

One hundred and eighty seven bean genotypes that included local landraces, pre-released and released varieties from Uganda were planted along universal checks in a lattice design with two replications in plots of 2 rows of 2 m long to identify potential sources of high seed Fe and Zn. The study was conducted at NARL, Kawanda in the second rainy season of the year (2011B). To determine Fe and Zn content levels, seeds were hand threshed under conditions that ensure the seed is kept free of dirt and dust as much as possible. The seed surface was cleaned by rubbing with a wipe dampened in distilled water, then dried at 60^{o}C for 12 hours. The seeds were then ground using Sunbeam conical burr mill EM0480 grinder. The amount of Fe and Zn was determined by X-Ray Fluorescence (XRF) spectrometry at the Rwanda Agriculture Board (RAB) laboratory. The analysis of variance was performed by the ANOVA statistical procedure of Genstat 14th edition package. Linear regression analysis from Microsoft excel was used to identify potential sources high in both iron and zinc.

Research Application

The average levels of iron and zinc content in tested gemplasm were 61 and 33 mg/kg respectively (Table 1).Ugandan germplasm contain genotypes with higher than average levels of iron and zinc in their seeds (Table 2). The selected potential sources of iron and zinc ranged above 75mg/kg for iron and above 35mg/kg for zinc while the high universal check variety; MIB 465 had 75mg/kg of Fe and 43mg/kg of Zn. The low Fe check; CAL96 had 56mg/kg of Fe and 30mg/kg of Zn (Table 2). Identified varieties with high iron and zinc content (Table 2; Fig. 1) among Ugandan germplasm should be used in the breeding program to improve mineral contents of other bean

Table 1. Summary analysis of variance.

Source of variation	DF	Mean squares Iron content	Zinc content
Rep	1	0.1 ns	43.8 **
Genotype	186	116.2 ***	22.3***
Residual	183	27.2	4.9
Total	370		
Means		61.4	33.0
CV (%)		8.5	6.7

Table 2. Mean seed content of iron and zinc in selected Ugandan bean genotypes grown in Uganda (2011B).

Genotype	Mineral content in seed (mg/gm)		Categorization
	Iron	Zinc	
UGK116	87	36.5	High Fe and Zn
UGK4	85	37.5	
UGK103	78	36.5	
UGK149	78	36	
UGK95	78	35	
UGK111	77	40	
UGK72	77	37	
UGK117	76	37	
UGK39	76	35	
UGK85	74	39	
UGK43 (Control)	75	43	
UGK68	77	34.5	High iron
UGK45	63	40	High Zinc
UGK47	62	40	
UGK92	61	40	
UGK19	70	39	
UGK86	48	30	Low Fe and Zn
UGK10	46	29	
UGK70	50	28	
UGK13	48	27	
UGK174	47	26	
UGK180	46	31	Low Fe
UGK146	45	32	
UGK17	62	27	Low Zn
UGK14	53	22	
UGK156 (Control)	56	30	Low iron and zinc

varieties. Heritability estimates and QTL discovery should be studied in crosses between genotypes of high and low mineral content.

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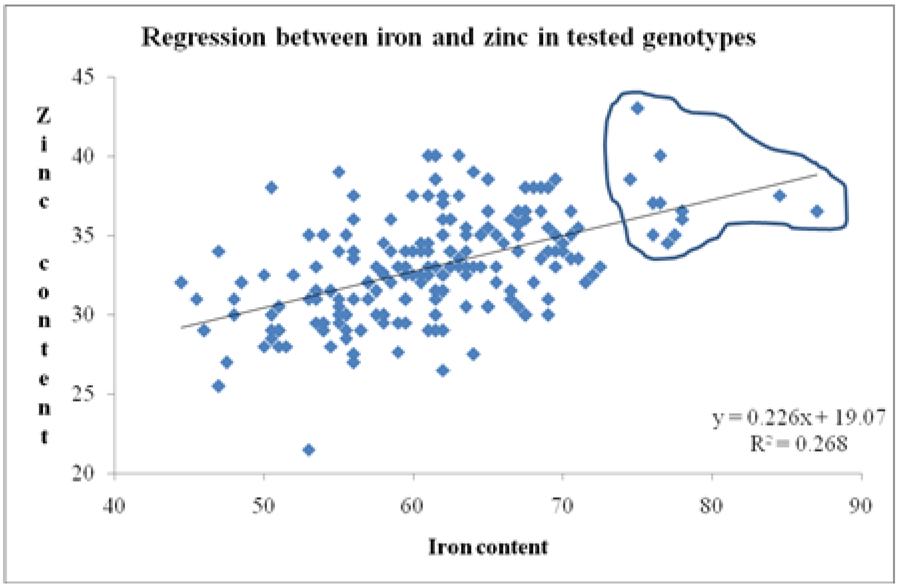

Figure 1. Regression between iron and zinc content in tested materials.

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