Mutambuka M, Hendrich S*, Murphy PA, Reddy MB

Department of Food Science and Human Nutrition, Iowa State University, Ames, IA, USA. *Presenter (shendric@iastate.edu)

White Common Beans (*Phaseolus vulgaris*) have Higher In vitro Iron Bioavailability than Colored Seed Coat Varieties

ABSTRACT

Objective: *Common beans are an important source of iron in developing countries, yet there is need and potential to improve their iron bioavailability. This study aimed to model iron bioavailability with respect to key influencing factors; protein, polyphenol, phytate, bean ferritin and iron content, as well as establishing effects of extrusion cooking.* ***Methodology:*** *A caco2 cell culture model was used to determine iron uptake from in vitro digested bean samples while Response Surface Methodology (RSM) was used for process optimization.* ***Results:*** *Protein content ranged from 25.7-31.6%; polyphenol, 0.07-0.37 mg/100g; phytate, 0.91-2.17 g/100g; iron, 74.9-119.5 µg/g; bean ferritin, 206-497 µg/g, and relative iron bioavailability (based on 100% bioavailability of ferrous sulfate) was 9.1-52.1%. White coated varieties had the highest bioavailability. A fixed effects multiple regression model showed negative effects of polyphenol and positive effects of iron and ferritin interactions. Extruder temperature had greatest effect on extruded flours, increasing polyphenol content and expansion ratio while reducing peak and final viscosities.* ***Significance:*** *Polyphenol content is the major determinant of iron bioavailability in common beans, which in turn can be indirectly screened for by seed coat color.*

Introduction

Iron deficiency is the most prevalent nutritional deficiency in the world. Particularly affected are populations in developing countries dependent on local staples for their iron nutrition. Common beans are an important source of iron and there is need and potential to improve their iron bioavailability (FeBA) through breeding and processing technologies.

Objective: This study therefore aimed at modeling bean FeBA with respect to key influencing factors; protein, polyphenol, phytate, bean ferritin and iron content, as well as establishing effects of extrusion cooking.

Methodology

A Caco-2 cell culture model was used to determine iron uptake from in vitro digested bean samples; while Response Surface Methodology (RSM) was used for optimizing processing variables in producing bean flours, including moisture content, barrel temperature and flow rate. Standard procedures were used to measure chemical composition of beans.

Results

Protein content ranged from 25.7-31.6%; polyphenol, 0.07-0.37 mg/100g; phytate, 0.91-2.17%; iron, 74.9-119.5 µg/g; bean ferritin, 206-497 µg/g, and relative FeBA (based on 100% bioavailability of ferrous sulfate) was 9.1-52.1%. White coated varieties had the highest bioavailability and were significantly different from colored seed coat varieties, which in turn were not significantly different from each other (Fig. 1). A fixed effects multiple regression model showed negative effects of polyphenol and positive interactive effects of iron and ferritin content (Box 1). Extrusion processing of Nabe6, the small seeded white variety, produced consumer acceptable flours with significantly reduced peak and final viscosity; and antinutritional factors content. Extruder barrel temperature had greatest effect; increasing polyphenol content and expansion ratio while reducing peak and final viscosities (Fig. 2).

FeBA=129-4935PP-1.9Fe+84PP*Fe-2.2PP*FER+0.0006Fe*FER

FeBA-Iron Bioavailability; PP-Polyphenol; Fe-Iron; FER-Ferritin

Box 1: Predictive model for Iron Bioavailability showing predominant effect of polyphenol content

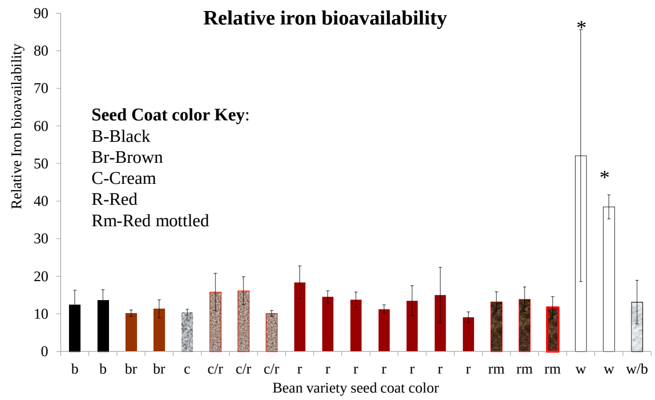

Figure 1: Relative iron bioavailability of bean varieties (* signify statistical significance of difference across varieties at p<0.001, Error bars are Std Dev)

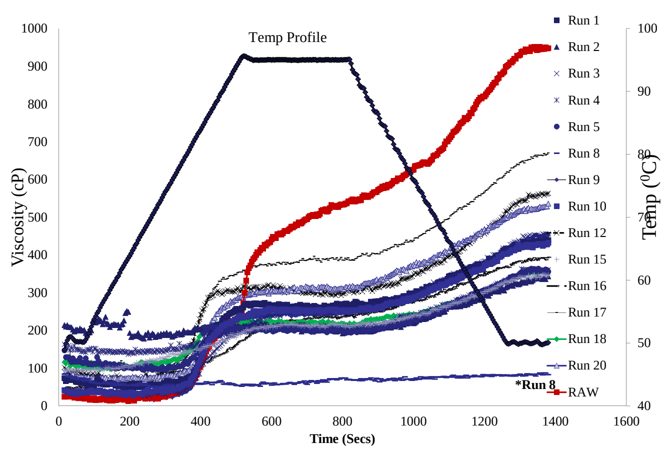

Figure 2: Pasting properties of extruded bean flour (*Run 8; highest barrel temp at lowest flow rate had greatest reduction on paste viscosity)

Significance

The chemical composition of beans has significant effect on FeBA and efforts in increasing iron content ought to be matched with appropriate changes in key influencing constituents. In this study, iron, polyphenol and ferritin content were significant determinants of FeBA. Effect of phytate content was not significant. Further, FeBA may be indirectly screened by seed coat color. Extrusion cooking significantly reduced paste viscosity, improving nutrient density for weaning and malnutrition intervention foods.

Acknowledgements: The study was made possible through research grant by US-AID under the Dry Grain Pulses CRSP project