

# Effects of Bran Fortification on Physical Characteristics and Antioxidant Activity in High Tannin Sorghum Extrudates

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## Abstract

A Hi-Tannin sorghum (whole or cracked) with addition of various levels of bran (15%, 30%, or 50%) produced by roller milling or decortication were extruded through a high-shear Maddox MX-3001 Extruder. Whole sorghum was successfully extruded into average quality products, cracking the sorghum improved the texture of the extrudates. Extrudate expansion ratio decreased and bulk density increased, with the addition of bran, more significantly in decorticated bran added samples. ESEM pictures revealed that milled bran aided in the support of extrudate expansion, while decorticated bran hindered expansion. Overall extrudate antioxidant activity and phenols increased with increased bran fortification. However, actual percentage of antioxidant activity retention in extrudates decreased with increased bran.

Fig. 2 – Raw Materials Production Flowchart

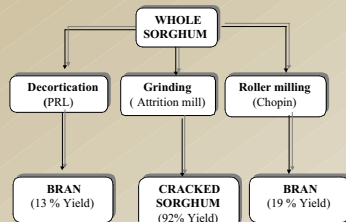


Fig. 3 – Extrusion Processing Flowchart

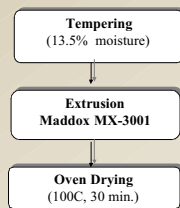


Fig. 4 – Extrudates



Extrudates from whole and cracked tannin sorghum and those from fortified cracked sorghum at different roller-milled bran substitutions.

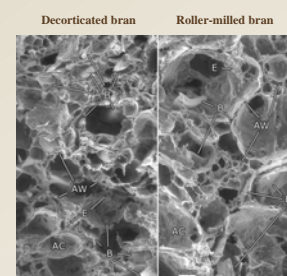
Table 1. Fiber and protein composition of selected material (dry wt)

Treatment	Protein %	Crude Fiber %	Dietary Fiber %
Whole sorghum	12.6	4.5	***
Cracked sorghum	11.2	5.1	***
Bran(decort.)	8.7	11.6	40.3
Bran (roller-milled)	11.6	7.7	29.4
50% decort. bran extrudate	***	8.6	18.0

• Decorticated bran contained less starch and fewer endosperm pieces than milled bran.

## Environmental Scanning Electron Microscopy

Fig. 7 – ESEM photos of 50% bran substituted extrudates



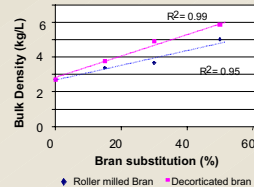
B – bran pieces, E – endosperm, AW – air cell walls, and AC – air cells

- Decorticated bran inhibited expansion of the air cells and air cell walls; the small size added no support to the air cell walls and the pieces tended to roll up during processing.
- Roller-milled bran retained its conformation, and acted as support to the air cells and walls.
- Particle size differences or other unknown factors may be responsible for the decorticated bran behavior.

## Results and Discussion

### Effect of bran addition on extrudate quality

Fig 5. Change in expansion ratio of extrudates with bran addition



- Bulk density of extrudates increased with bran addition.
- Decorticated bran produced extrudates with higher bulk density than roller-milled bran.

### Effect of extrusion on phenols and antioxidants

Fig 8. - Change in antioxidant activity due to extrusion at different roller milled bran levels

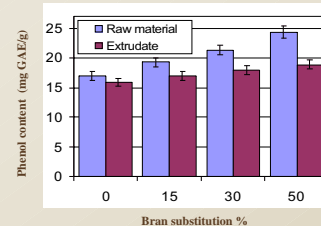
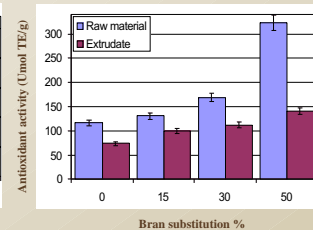


Fig 9. - Change in antioxidant activity due to extrusion at different roller milled bran levels



## Introduction

Tannin sorghums have high antioxidant activity. Bran from these sorghum bran has been used to produce cookies and bread with high antioxidant activity and good sensory attributes (Awika 2003).

Fortification with high antioxidant sorghum bran could impart nutraceutical properties to extruded snacks and other foods.

## Objectives

To determine how sorghum bran fortification affects physical and antioxidant characteristics of extrudates.

## Materials and Methods

• 2001 College Station high-tannin sorghum

• Cracked sorghum was obtained by grinding whole sorghum in an attrition mill (Glen Mills Inc. Maywood, N.J.).

• Sorghum brans were obtained by roller milling (Chopin mill, Perten, Springfield, IL) and decortication (PRL Mini-Dehuller, Nutana Machine Co., Saskatoon, Canada).

• Brans were added to cracked sorghum at 0, 15, 30, and 50 % of the batch weight.

**Bulk Density:** weight of extrudates in a 15 L container divided by volume.

**Expansion Ratio:** extrudate diameter divided by die diameter.

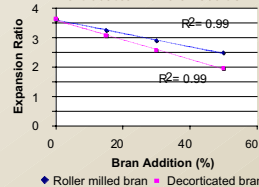
**ESEM:** Electroscan Model E-3 Environmental Scanning Electron Microscope; extrudate microstructure.

### Antioxidant activity and phenols:

• DPPH method used for antioxidant assay.  
• Total phenols: Folin-Ciocalteu method.

**Fiber and protein:** dietary fiber measured by the Prosky method, protein and crude fiber measured by NIR

Fig 6. Change in expansion ratio of extrudates with bran addition



- Increased bran addition caused a decrease in expansion.
- Effect was more pronounced in decorticated bran extrudates.
- Smaller particle size (Fig 1) and higher fiber content (Table 1) were likely responsible.

## Summary

- Whole tannin sorghum can be extruded into snacks. Cracking the sorghum improves the texture of the extrudate.
- Bran incorporation improved nutrition (fiber and antioxidants) of extrudates. However, the texture was harder.
- Tannin sorghums are potentially viable ingredients for healthy extruded snacks.

## References

Awika, J. 2003. PhD Dissertation: Texas A&M University, College Station, TX.  
Awika, J.M., Dykes, Gu, L.L. Rooney, L.W., Prior, R.L. 2003. Processing of sorghum and sorghum products alters procyanidin oligomers and polymer distribution and content. J. Agric. Food Chem. 51:5516.

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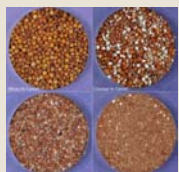


Fig 1

Whole (left) and cracked sorghum

Roller-milled (left) and decorticated Brans