Decortication Level and Particle Size Effect on Direct-Expanded White Sorghum Extrudates

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Abstract

White sorghum samples prepared by combining 4 different decortication levels (0, 10, 20 and 30%) and three particle sizes were extruded in a Maddox single screw friction-type extruder. A commercial yellow cornmeal and polished rice were extruded as controls. The extrusion conditions were held constant for all samples. The expansion ratio, bulk density, color and texture of the extrudates were significantly affected by both particle size and decortication level. As the decortication level increased, the extrudates tended to be whiter, more expanded, less dense, crispier and more viscous. The extrudates made from coarse particle size materials had more desirable characteristics when compared to the other particle sizes used. Some sorghum products had a higher expansion ratio than both rice and corn, and had similar bulk density and texture characteristics.

Introduction

Extrusion cooking is used to produce a wide variety of food products with unique sensory attributes (Desrumaux et al, 1999). Extruded food materials undergo various transformations, including starch gelatinization and fragmentation, and protein denaturation, which affect the product properties.

The most common cereals used in the extrusion of snacks and breakfast cereals are corn, wheat, rice and oats. Sorghum is not a major ingredient in extruded snacks and breakfast cereals (Riaz, 1997). New white food sorghum hybrids produce light colored, bland flavored grains that have some advantages for production of unique products. The performance of these new sorghums in different extrusion systems has not be thoroughly evaluated.

Objective

Determine the effects of decortication and particle size on the characteristics of direct-expanded white sorghum extrudates.

Materials and Methods

Samples

Grain of a white sorghum (ATx631 x RTx436) was decorticated to remove 0, 10, 20 and 30% of kernel weight. The whole sorghum and the decorticated samples were hammer-milled using a Fitz mill and sieved. Overs of US Standard Sieves # 20 (coarse) and 50 (meal) were retained. Samples of each decortication level without milling (whole, decorticated grain) were used also. ConAgra yellow corn meal and polished long grain rice were used as controls.

Extrusion was performed in a single screw, friction-type Maddox Extruder Model MX-3001. All samples were tempered to 14% moisture; 300 rpm screw speed was used. The die used had 6, 1/8 inch holes.The temperature varied according to the friction each sample produced . Each sample was extruded until a steady state was reached and extrudates were sampled.

Baking of samples was performed after extrusion in a tray oven at 100 C for 30 min. After baking, the samples were cooled and packaged in metallic plastic-film.

Expansion ratio was the diameter of the extrudates measured with an electronic caliper divided by the diameter of the die.

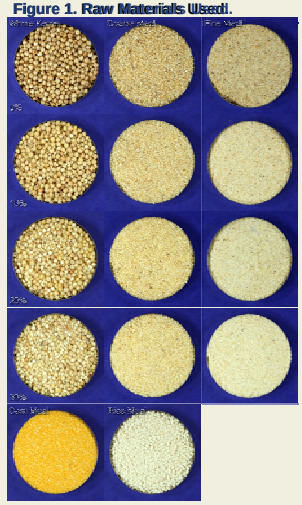
Bulk density was obtained by dividing the weight of extrudates that filled a container of known volume.

Texture of the extrudates was evaluated using a Texture Analyser TA-XT2 with an aluminum blade as a probe. 10 randomly selected extrudates per treatment were analyzed. The area under the curve F*t and the number of peaks were registered.

Color (L and chroma) was determined on ground extrudates passing through US standard no. 40 sieve (Hsieh et al, 1993) with a Minolta Colorimeter using CIE L*a*b* values.

Statistical Analysis was performed with SAS V8 for Windows software, using α=0.05.

Figure 1. Raw Materials Used.



Raw Materials :
- Lighter appearance occurred as more pericarp was removed and as the particle become smaller.
- Corn meal appears yellow, and rice was white.

Results

Table 1. Average Values for All Treatments

TREATMENT decort./particle	BULK DENSITY (g/ml)	AREA F*T g s	# PEAKS	L	CHROMA	EXPANSION RATIO
0% WHOLE	0.123 a	13446 b	40.7 f	78.94 g	15.21 b	3.32 i
0% COARSE	0.062 d,e	11842 c	51.1 d,e	81.10 f	15.32 b	4.41 g
0% MEAL	0.123 a	11688 c	33.1 g	75.51 h	15.35 b	3.17 k
10% WHOLE	0.075 b,c	12401 b,c	50.2 d,e	82.51 e,f	14.77 c	4.20 h
10% COARSE	0.041 g	9950 d	53.2 d,e	84.91 b,c,d	13.99 e,f	4.86 b,c
10% MEAL	0.072 c	13055 b,c	48.7 e	82.56 e,f	14.44 c,d	4.00 i
20% WHOLE	0.047 f,g	13519 b	62.2 a,b	83.57 d,e	14.53 c	4.56 e,f
20% COARSE	0.069 c,d	11814 c	54.5 c,d,e	85.93 a,b,c	13.83 e,f	5.04 a
20% MEAL	0.056 e,f	12625 b,c	52.4 d,e	83.88 d,e	14.10 d,e	4.41 g
30% WHOLE	0.067 c,d	15350 a	60.7 a,b,c	84.73 c,d	12.99 g	4.75 c,d
30% COARSE	0.056 e,f	13713 b	54.7 c,d,e	86.27 a,b	13.72 f	4.92 a,b
30%MEAL	0.055 e,f	13644 b	56.0 b,c,d	84.55 c,d	13.66 f	4.67 d,e
CORN	0.055 e,f	9268 d	65.7 a	84.63 c,d	34.42 a	4.78 c,d
RICE	0.085 b	12837 b,c	65.1 a	87.40 a	10.89 h	4.55 f
LSD (α=.05)	0.009	1466	6.6	1.5197	0.3666	0.118

- Some sorghum samples expanded more than corn or rice; these extrudates had similar bulk densities and texture characteristics.
- Decorticated sorghum samples yielded extrudates with bland flavor.

Table 3. Comparison of Different Particle Sizes (Average of all Decortication Levels)

TREATMENT	BULK DENSITY (g/ml)	AREA F*T g s	# PEAKS	L	CHROMA	EXPANSION RATIO
PARTICLE SIZE						
WHOLE	0.078 a	13679 a	53.45 a	82.44 b	14.38 a	4.21 b
COARSE	0.057 b	11830 c	53.38 a	84.55 a	14.22 a	4.81 a
MEAL	0.077 a	12753 b	47.55 b	81.62 c	14.39 a	4.06 c
LSD (α=.05)	0.001	771	3.2	0.81	0.18	0.05

Figure 2. Extrudates From Each Treatment.

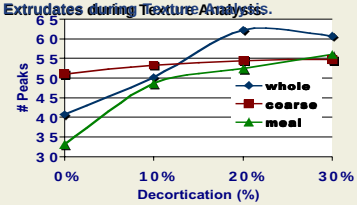
- As can be seen in the pictures, the color of the extrudates was affected by both the decortication level and particle size
- The Chroma was affected by the decortication level.
- Chroma decreased as decortication level increased, as expected.
- Extrudate Lightness was affected by both the decortication level and particle size.
- The Lightness increased as the decortication level increased to 20%.
- Extrudate Lightness was higher prepared from coarse, followed by whole decorticated grain and meal.

Table 2. Comparison of Different Decortication Levels (Average of all Particle Sizes)

TREATMENT	BULK DENSITY (g/ml)	AREA F*T g s	# PEAKS	L	CHROMA	EXPANSION RATIO
DECORTICATION						
0	0.103 a	12326 b	41.6 c	78.52 c	15.30 a	3.63 d
10%	0.063 b	11802 b	50.7 b	83.33 b	14.41 b	4.36 c
20%	0.058 c	12653 b	56.3 a	84.46 a	14.16 c	4.67 b
30%	0.059 c	14236 a	57.1 a	85.18 a	13.46 d	4.78 a
LSD (α=.05)	0.002	890	3.8	0.93	0.21	0.06

- Bulk density of extrudates decreased as decortication level increased.
- The bulk density was lower for the coarse particle size samples.
- Bulk density was affected by both particle size and decortication levels.

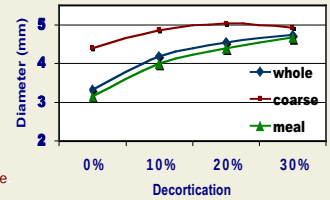
Figure 4. Number of Peaks during Breakage of Extrudates during Texture Analysis.



- The number of peaks (an indication of crispness) was affected by the particle size, decortication level and their interaction.
- The number of peaks increased as the decortication level increased
- The number of peaks increased as the particle size increased.

- Decortication and particle size affected the area (an indication of the work of initial bite).
- The 30% decorticated samples had larger areas compared to all other samples.
- Extrudates prepared from whole and decorticated grain also had larger areas, followed by meal and coarse.

Fig. 3 Expansion Ratio of Extrudates.



- Coarse particle size expanded more during extrusion, regardless of level of decortication (top line of graph).
- The expansion ratio increased as the decortication level increased (as expected).
- The expansion ration of extrudates was affected by the particle size, decortication level and their interaction.

Conclusions

- Whiter, more expanded, stronger, crispier, and bland flavored extrudates were produced using sorghum with increasing decortication level.
- Extrudates with better characteristics were prepared with coarse particle size ingredients.
- Extrudates from some sorghum samples were similar to corn or rice extrudates.
- Variation in decortication level and particle size affect extrudate characteristics such as expansion ratio, crispness and bulk density.
- Extrudates with good characteristics can be produced without milling or by decorticating sorghum.
- Low-cost, friction extruders can be used to produce an array of products.

Acknowledgements

Partial financial support from the USAID-INTSORMIL Title XII CRSP. We appreciate the long term use of the Maddox extruder from the Maddox Metal Corporation, Dallas, TX.

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