The Effects of a Rice Based Emulsifier on Extruded Corn Meal

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Abstract

Commercial de-germed corn meals with and without 0.5% of a rice based emulsifier were extruded using a single screw high temperature-high shear baking extruder. The physical, texture, and microstructure of the two samples were compared. The extrudates containing 0.5% of the rice based emulsifier had a lower bulk density compared to the control. Viewed with environmental scanning electron microscopy, the extrudates without the emulsifier had more air cell walls that had a more consistent size and shape. Extrudates with emulsifier were more evenly distributed air cells with thinner air cell walls that had a more consistent size and shape. Extrudates with emulsifier were more evenly distributed air cells with thinner air cell walls.

Materials and Methods

Materials

Degerminated yellow corn meal from ADM Milling, was used. The rice based emulsifier (Nu-Rice) was provided by Ribis, Inc. (St. Louis, Missouri 63105, USA).

Sample Preparation

For the control ten kilograms of degenerated yellow corn meal was tempered to 14% moisture content. Another ten kilograms of degenerated yellow corn meal was mixed with 0.5% of the emulsifier and was tempered to a moisture content of 14%.

Extrusion

The corn meal was extruded using a single screw, LD friction-type Maddox Extruder Model MX 3001. A screw speed of 300 rpm and an average barrel temperature of 308°C were the running conditions. A 6 hole die with 1/8 inch openings was used.

Results

Bulk density

The bulk density (g/L) was obtained by dividing the weight of the extrudates that fill a container by the known volume of the container.

Texture

The texture of the extrudates was evaluated with a Texture Analyzer TA-XT2i (Texture Technologies Corp., Scarsdale, NY) with a 50 N load cell. Forty randomly selected extrudates per treatment were analyzed.

Results

Table 1. Particle Size Distribution of Corn Meal

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Figure 1. Mean Force (g) for Puncture Extrudates

- Control
- Extrudates with 0.5% Emulsifier
- There was a decrease in bulk density in the extrudates containing 0.5% Emulsifier.
- Less force was required to puncture extrudates from corn with emulsifier.
- Thus, cell walls from the extrudates with emulsifier are probably thinner.
- This can be correlated with the images in Figure 1.

Figure 2. Elastic (Young’s) Modulus of Corn Extrudates

- Control
- Extrudates with 0.5% Emulsifier
- There was a decrease in bulk density in the extrudates containing 0.5% Emulsifier.
- Less force was required to puncture extrudates from corn with emulsifier.
- Probably because lower elastic modulus, less distance required to break the cell wall.
- Extrudates with emulsifier were softer.

Conclusions

A 0.5% addition of the rice based emulsifier to degenerated yellow corn meal did effect the physical, texture, and microstructure. There was a decrease in bulk density. The addition of the rice based emulsifier produced extrudates with thinner cell wall structures, that are more evenly dispersed. Due to the thinner cell structure less force is needed to puncture the extrudates providing a soft and crispier texture. There was a reduction in clumping of air cell structures, and thickness in the cell walls. Rice based emulsifier diminished the tunneling effect creating a more uniform cell structure in the extrudates.

Figure 3. Cross Section View of Corn Extrudates

- Air cells were slightly more evenly distributed in the emulsifier sample.
- There was a tunneling effect that was evident in the control causing air cells to become very elongated, traveling either longitudinally or radially throughout the collets.
- The tunneling effect was diminished in the collets with emulsifier, but not eliminated.

Figure 4. ESEM View of the Corn Extrudates

- Control
- Extrudates with 0.5% Emulsifier
- Air cells in the extrudates containing the emulsifier were more translucent than the control, indicating the smoother surface texture and thinner cell walls.
- Control air cell walls were textured, reflecting light rather than allowing it to pass through, contributing to a more yellow appearance.

Figure 5. Marco View of Corn Extrudates

- Control
- Extrudates with 0.5% Emulsifier
- Air cell walls in the extrudates containing the emulsifier were more translucent than the control, indicating the smoother surface texture and thinner cell walls.
- Control air cell walls were textured, reflecting light rather than allowing it to pass through, contributing to a more yellow appearance.