Extrusion Processing of Snack Food and Breakfast Cereals

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U.S. Snack Trends on the Increase

Snacking is a major source of nutrition for the U.S. consumer,

- 231 morning snacks are consumed per year.
- 283 afternoon snacks are consumed per year.
- 261 evening snacks are consumed per year
- Children 6-13 years of age are among the most frequent snackers consuming on average 840 snacks per year

Terminology

1st Generation Snacks
Nuts, dried Fruit, cracker, potato chips, tortilla chips
Terminology

2nd Generation Snacks
Majority fall in this category
Puffed collets, Baked or Fry

Fundamentals of Grain Based Food
Extrusion Processing

- Formulation (Recipe)
- Hardware
- Software
- Product Specifications

Terminology

3rd Generation Snacks
3-G, Half Products, Puffed later by hot air, frying, or microwave
Raw Materials

- Major components in Snack Food
  - Carbohydrates
  - Proteins
  - Lipids

Raw Materials

- Minor components for Snack Food
  - Minerals
  - Vitamins
  - Pigments
  - Flavors
  - Other additives

Hardware
Extrusion: A Novel Food Processing Tool

Extrusion Processing Technologies for Snack
Dry Extruders (Short Time / High-Temperature Extruders)
Expander/Cooker Extruders
Single Screw Extrusion Cookers
Twin Screw Extrusion Cookers

Types of Extruder
- **Single screw**
  - Simpler and cheaper
  - Limited mixing and flexibility
  - Range of raw materials limited
  - Low tolerance to lipids in raw materials and moisture variations
- **Twin-screw**
  - Flexible, wide range of raw materials
  - High level of micro-mixing
Extruder Die
- Provides resistance at discharge of extruder
- Shapes product
Direct Expanded Snacks

- Simple shapes
- Simple raw materials
- Simple process
- Externally coated/seasoned
Third Generation Snack

- More complex shapes
- More complex raw material blends
- More complex process
- Stable, shelf stable pellet that is puffed later

What are half-products?

- Name, dry, shelf-stable, cooked pellets that are expanded some time after formation into crunchy or crispy snack products
- They are “half” or partially made, then finished later
Other names for half-products...

- Third generation snacks (3G snacks)
- Snack pellets
- Indirect expanded snacks

Benefits of the half-product production method

- Good shape definition not possible with direct expansion
- Product textures not possible with direct expansion
- Can use raw materials not compatible with the direct expansion process
- Can process in one location, then ship dense pellets to a location closer to the market for puttying, coating, and packaging

Disadvantages of the half-product production method

- Much greater equipment cost
- More complex operations
- Final product result not seen for at least 1 hour later making it difficult to provide real-time process feedback
- More flexibility = greater complexity!!
Generic half-product process

Cook → Shape → Dry

Store/Transport

Package → Cool → Puff

Cooking Methods

- Use of pre-gelatinized materials and cold extrusion
- Batch cooking followed by sheeting
- Single screw cooker with single screw former
- Twin screw cooker with single screw former
- Twin screw cooking/forming combination process

Use of pre-gelatinized materials and cold former

Moistening

Forming Extruder

Feeding
Recipes for half products

- A wide range of recipes are possible
- Recipes can be tweaked to change product properties and has more impact than changing processing conditions

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<tr>
<th>Ingredient</th>
<th>Percentage</th>
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<tr>
<td>Corn Flour</td>
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<tr>
<td>Wheat Starch</td>
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<td>Modified Tapioca Starch</td>
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<tr>
<td>Rice Flour</td>
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<td>Sugar</td>
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<td>Salt</td>
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<tr>
<td>Emulsifier</td>
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Shaping and Cutting Options

- Shaping and cutting at extruder die
- Shaping at extruder die/cutting later
- Sheeting at extruder die/rotary die cutter
- Sheeting at extruder die/laminating/rotary die cutter

Shaping at extruder die

- Limited to shapes with symmetrical openings

Symmetrical Opening

Irregular Opening
Cutting at extruder die

- Short shapes cut horizontally
- Long shapes require vertical extrusion or downstream shaping

Cutting at extruder die

- Product stickiness requires knife blade to be tensioned against die surface

Horizontal Die-Face Cut Products
Drying of snack pellets

- Low temperature (80-100°C)
- High humidity (3%-4%)
- Long time (longer than 1 hour) – very dependent on shape and thickness
- Multiple pass conveyor-style dryers – often preceded by a pre-dryer to enable deeper bed depths in the conveyor dryer
- Steam heated

Caution: Over-drying leads to stress cracking and insufficient moisture remaining for puffing.

Snack Pellet Dryer

Tempering

- Hold time required to allow moisture equilibration within product pieces
- Longer is better
- Required to result in more uniform product textures
Extruded and Fried Snacks

Fried Cheetos Curls  Multi-Grain Chips

Extruded and Fried Snacks
Extrusion: A Novel Food Processing Tool
Co-Extruded / Filled Products

Co-Extruded Snacks
Extrusion cooking is...

a very flexible processing tool that using the proper raw materials, hardware, and processing techniques can produce a wide range of snack food and breakfast cereals.