Challenges in Sustainable Ingredients Processing

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Consumer-Driven Trends in Pet Foods

- Increasing demand for high quality ingredients and formulas
- Increasing demand for variety and unique ingredients
- "Humanization" of pets increasing
- Focus on protein source

Industry Response

- Some movement away from rendered by-products
- Novel animal protein sources (bison, elk, salmon, turkey, duck, kangaroo, wild boar)
- Unique replacements for grains such as lentils, peas, and potatoes
- Increased focus on quality and novelty - differentiation

Results in pain for the Manufacturers in Processing Challenges

- Expanded ingredient inventory
- Raw material variation
- Nutrient losses
- Product stability
- Control of safety hazards
- Production costs

Sustainable Whole Ingredients

- "Renewable" resources – most ingredients used in pet food manufacturing would be considered sustainable.
  - Grains
  - Legumes/pulses - Beans, peas, lentils, chickpeas
  - Fresh meats
- Non-sustainable pet food ingredients
  - Natural vitamins and minerals – synthetic alternatives

Sustainable "Co-product" Ingredients

- Brans, fibers, starches, bagasse, fruit and vegetable pomaces
- Meat meals, proteins, "wet" meat by-products
- Fats and oils
- Waste streams from the extrusion process
- Growing in demand for pet food formulations
  - Product differentiation
  - Considered sustainable as well as they are generated from milling and meat processing industries

Common Ingredient Challenges to Extrusion Processing

- Variability

- Specific to Co-products:
  - Nutrient profiles
  - Efficiency of processing varies
  - Not target product for processors so less care given to variability
- Storage and stabilization for high moisture ingredeints
- Fats and oils – stability and separation
- Not all ingredients are created equal

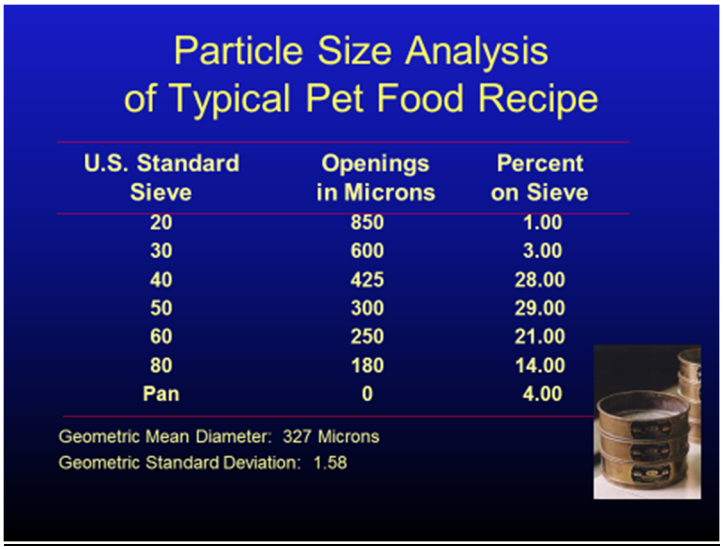
Common Ingredient Challenges to Extrusion Processing
Variability:

- Particle size
- Moisture and other nutrients
- Impact of growing season, growing climate, and storage conditions
- Ingredient variety
- Time between grinding, mixing, and extruding
- Inherent in co-products

Benefits of Proper Particle Size

- Improved product appearance
- Reduced incidence of die orifices plugging
- Greater ease of cooking
  - Reduced product breakage and fines
  - Increased water stability & absorption
  - Lower bulk density and softer texture
  - Higher levels of starch gelatinization
  - Higher throughputs for given extruder and preconditioner
  - Less wear on extruder components for a given rate
  - Lower microbial survival rates
  - Improved digestibility and palatability
- Improved retention of liquid coatings due to cell structure

Particle Size Analysis
of Typical Pet Food Recipe



Guidelines for Grind of Recipe

- Maximum particle size = 1/3 of die opening

- No particle to exceed 1.5 mm (1/16")
- Mixed recipe coefficient of variation (CV) < 10%

Natural Ingredient Variants

- Growing season and climate
- After ripening factor - Biochemical changes occur after harvest and are influenced by storage time.
- Variety – Not all ingredients are created equal
  - Ex. - Long versus short grain rices – both called "Rice"
  - Starch composition – amylose and amylopectin content
- Nutrient composition
  - Yields
  - Moisture content
  - Natural ingredients have natural variation

Co-product Processing Variants

- Not target product for processors so less care given to variability
  - Nutrient profiles
  - Yield and efficiency of processing varies
- Nutritional content variation – moisture, fat, protein
- May require further processing to reduce variability – grinding, screening, mixing

Fresh Meat and "Wet" Co-products

- Storage and handling
- Stabilization typically required
  - Fat oxidation
  - Mold
  - Biogenic amines
- Re-work or regrind of extrusion process waste
- Labeling

Effects of Adding Rework to Recipe

- Dependent on inclusion level
- Darker color
- Less expansion, heavier bulk density
- Higher levels of cook
- More defined shape

Fresh Meat Preparation

What is the best form for handling fresh meat within a plant?

Ingredient Specific Challenges

A more specific review of ingredients by family

- Proteins – Vegetable and Meat
- Starches – Grains and Vegetables
- Fibers
- Fats and Oils

Protein

1) Plant sources

Soy, Legumes, Wheat/Corn Glutens, Cereal Grains

- Good functional properties
- Low cost
- Amino acid profile requires supplementation

2) Animal sources

Meat, Fish, Poultry, Blood, Gelatin

- Poor functional properties unless fresh or spray dried
- Higher costs but usually more palatable
- Good amino acid profile

Processing Effects on Proteins

- Denaturation of Proteins
  - Begins to occur at 55°C (130°F)
  - Measure PDI (Protein Dispersibility Index)
  - Digestible in acidic environment

- Heat- Damaged Proteins (poor digestibility)
  - Can begin at 150°C (302°F)
  - Measure N_2 in acid detergent fiber fraction
  - Poor digestion in acidic environment

Protein denatures at 60 - 70^{0}C

- As protein denatures, it becomes insoluble (non-functional)

Starch gelatinizes at 55 - 75^{0}C

- As starch gelatinizes, it becomes soluble or more functional

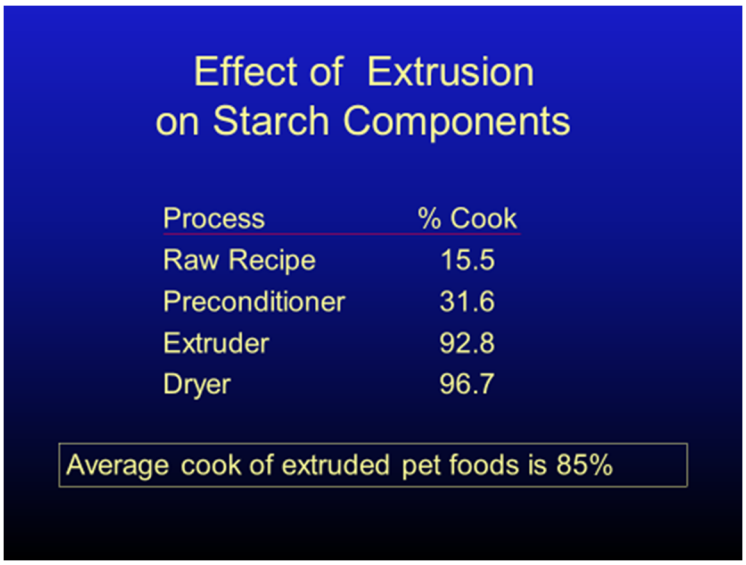
Vegetable Protein Sources with Substantial Starch Contributions

Dry Beans and Pulse Ingredients

- Significant source of protein, starch, fiber
- Low in fat and sodium
- Non-allergenic, non GMO, gluten-free
- Cholesterol free
- Oligosaccharide content of 2.5-5.0%
- Will impact color of food
- Can be sticky

Starch

- Carbohydrate - energy source
- Assists expansion
- Improves binding & pellet durability
- Found in two forms
  - Amylose
  - Amylopectin
- 10 - 60 % levels in pet food



Rice as a Starch Source

- Small, tightly packed granules that hydrate slowly
- Becomes sticky when it gelatinizes
- Choose long grain varieties over medium and short grain varieties as they are much less sticky when cooked
- Rice is very digestible even when cook values are low

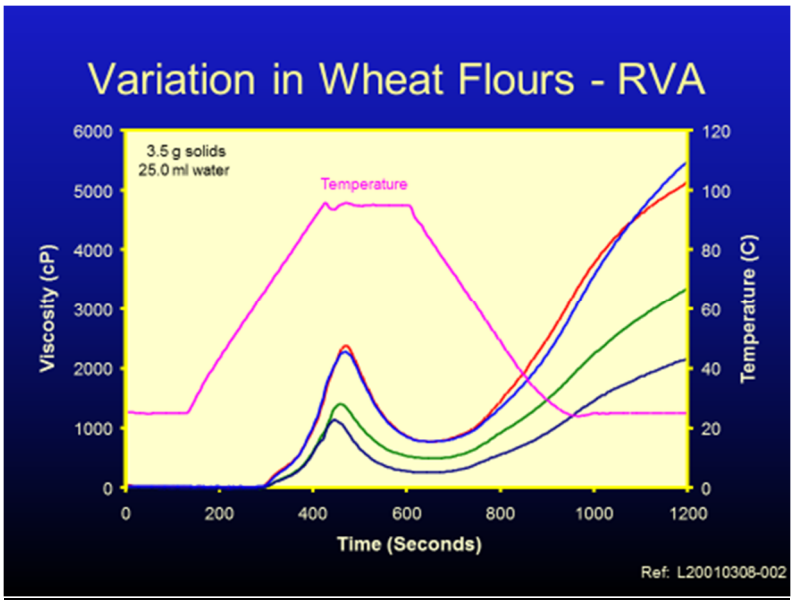
Corn (Maize) as a Starch Source

- Good expansion
- Excellent binding
- Sticky at high levels (>40%)

Wheat as a Starch Source

- Good binding
- Good expansion
- Can be sticky if overcooked
- Contains gluten (good binder)

Variation in Wheat Flours – RVA



Cassava

(manioc, tapioca, yucca)

Potato Products

(binding, absorption)

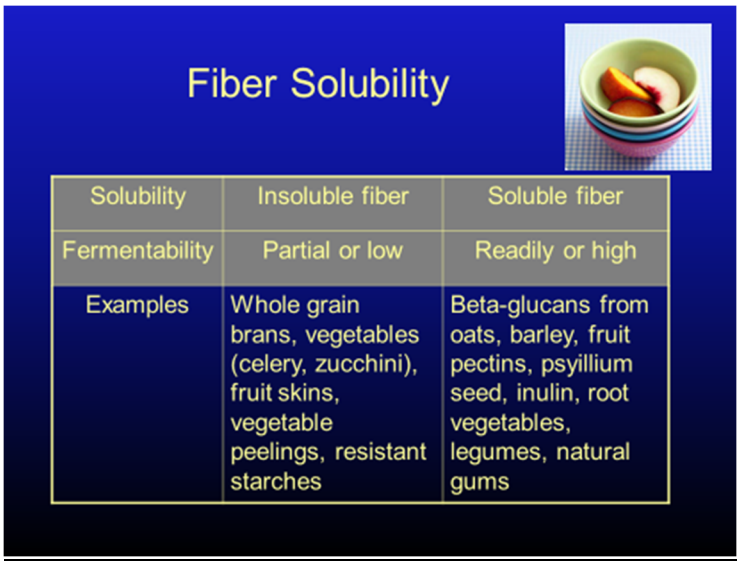
Tubers as a Starch Source

(Potato & Cassava)

- Excellent binding (at 5% levels)
- Requires less total starch in diet
- Good expansion
- Often precooked
- Smooth pellet surface
- Increased cost

To Reduce Stickiness and Surging in Extruder

- Oil or fat addition at 1-3%
- Emulsifier at 0.5%
- Reduce land length of die orifice
- Reduce steam level to preconditioner
- Change extruder configuration



Fat Sources

- Animal Fat
- Poultry Fat
- Marine Oils
- Blended Animal and Vegetable Fats
- Feed Grade Vegetable Fats

Purpose of Fat in Pet Foods

- Energy Source
- Palatability/Acceptance
- Essential Fatty Acids
- Carrier for Fat-SolubleVitamins
- Dust Control

Impact of Increased Fat Injected Into Preconditioner

- Larger cell structure
- Reduced SME (specific mechanical energy)
- Slower hydration of product in water
- Product quality improved if fat is added in coater
- Increased product density
- Reduced product durability – more fines
- More difficult to dry the product after extrusion

To Maximize Fat Inclusion Levels

- Formulate with ingredients high in indigenous fats (example is flax meal)
- Heat fats to 40 - 60^{0}C prior to inclusion
- Add late in the process
- Maintain starch / function protein levels
- Increase thermal and / or mechanical energy inputs
- Increase moisture levels during extrusion

Ingredient Challenge – "Control what you can Control"

- Comprehensive ingredient quality program
  - Ingredient specifications
  - Primary and secondary testing – receipt and skip lot testing
- Adequate particle size reduction and low CV mixing

- Extrusion Process flexibility
  - Automated controls
  - In-line monitoring
  - High Intensity Preconditioner, extruder VFD, BPV, WRS, etc.
- Equipment preventative maintenance

Thank You!!!

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