Proteins in modern pet foods: nutrient quality, processing and shelf-life considerations.

Greg Aldrich and Collaborators
K-State Pet Food Experience
September 14, 2016
Outline

• K-State Pet Food Program
• Introduction
  – The Pet Food Market
  – Pet Food Trends
• “Proteins” in Pet Foods
  – Functionality (gelatin)
  – Processing (amino acids)
  – Quality (oxidation)
• Summary and Implications
Pet Food & Nutrition Science

• Established KSU 2011
• Grain Science & Industry
  – Feed Science & Mgt
• Training: Short courses, Minor, BS, MS, PhD
• The impact producing safe pet food has on nutrient composition and shelf-life
Pets and Pet Food

• US – $60 B pet supplies, $ 24 B Pet Food
  – Estimated 8.5 MMT - $1 billion export
  – Dogs and cats – 164 million (APPA, 2015)
  – 150 million more including the birds, fish, horses, rodents
  – Pets live in 65% of homes

• Global Pet Food – $ 56 billion – 4% growth (Packaged Facts, 2011)

• Pet food manufacturing jobs – 22,420 (US; BLS March 2014) 50,000 (FEDIAF, 2010)
Pet Food Trends/Market Pressures

- Increased offerings of high protein low carbohydrate “no-grain” diets
- Growth in minimally processed, fresh, refrigerated-frozen, & raw diets
- Increasing number of “limited ingredient” and “novel ingredient” diets
- Expanding “NO” list (no corn, wheat, soy, beef, byproducts, beet pulp, menadione, etc.)
- Increased drive for natural/non-synthetic, domestic (non-China), and species specific ingredients
- Demand by retailers and distributors for longer shelf-life
- Fragmentation - life-stage, breed, (in)activity targeted, and special purpose foods
Animal based proteins in pet foods

• Research into protein ingredients in pet food has been of interest for decades.
• Early work focused on meeting minimum amino acid needs, issues of elimination in disease states, and characterizing safe upper limits.
• More recently the pet food industry has linked proteins to the carnivore as a vital source of nourishment (e.g. taurine) and dramatically expanded the repertoire of options.
Goal

• To evaluate [animal] proteins intended for modern pet food and treats
  – Structural support
  – Nutritional quality
  – Shelf-life and sensory attributes.
What is a Protein ????????
Structure
Main effect means of cross-sectional expansion* and PDI⁺

![Graph showing cross-sectional expansion and PDI for different gelatin bloom strength levels.

*\( \text{MSE} = 27.14 \); Each treatment \( n = 45 \)

⁺\( \text{MSE} = 7374.40 \); No Gel \( n = 10 \), Low \( n = 9 \), Mid \( n = 10 \), High \( n = 10 \)

\( \text{abcd} \) Columns or data points with unlike superscripts differ (\( P < 0.05 \))
Injection Molded Treats
Main effect means of gelatin type on physical characteristics of injection molded treats.

<table>
<thead>
<tr>
<th>Variable</th>
<th>PB100</th>
<th>PS175</th>
<th>PS250</th>
<th>SEM</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Puncture Force (kg)</td>
<td>15.46(^a)</td>
<td>14.11(^{ab})</td>
<td>12.59(^b)</td>
<td>0.80</td>
<td>0.06</td>
</tr>
<tr>
<td>Tensile Strength (MPa)</td>
<td>3.03</td>
<td>2.53</td>
<td>2.33</td>
<td>0.27</td>
<td>0.20</td>
</tr>
<tr>
<td>Strain at Break (%)</td>
<td>7.43(^b)</td>
<td>5.94(^b)</td>
<td>14.08(^a)</td>
<td>0.78</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Young’s Modulus (MPa)</td>
<td>128.11(^a)</td>
<td>97.81(^a)</td>
<td>44.21(^b)</td>
<td>14.15</td>
<td>0.004</td>
</tr>
</tbody>
</table>
Raw or Processed: Does it Matter?
Protein Quality Influenced by Processing:
Chick PER

- Spray Dried Egg Product
- Spray Dried Chicken
- Low Temp & Press Air Dried Chicken
- Low Temp Air Dried Chicken
- Chicken meal
- Chicken Byproduct Meal
Protein Quality Influenced by Processing:
Available Lysine, %

Spray Dried Egg Product
Spray Dried Chicken
Low Temp & Press Air Dried Chicken
Low Temp Air Dried Chicken
Chicken meal
Chicken Byproduct Meal
Protein Quality Influenced by Processing:
EAA:NEAA

Spray Dried Egg Product
Spray Dried Chicken
Low Temp & Press Air Dried Chicken
Low Temp Air Dried Chicken
Chicken meal
Chicken Byproduct Meal
Protein Quality Influenced by Processing: OH-Proline, %

- Spray Dried Egg Product
- Spray Dried Chicken
- Low Temp & Press Air Dried Chicken
- Low Temp Air Dried Chicken
- Chicken meal
- Chicken Byproduct Meal
Protein Quality Influenced by Processing

- Spray Dried Egg
- Dried Chicken Low Ash
- Dried Chicken High Ash
- Chicken Meal Low Ash
- Chicken Meal High Ash

Disruptive Technologies

Department of Grain Science and Industry
How is Pet food Shelf-Life Defined?

• The time it takes for the food to reach a point at which it becomes unacceptable
  – Offensive odor to the pet owner
  – Buildup of harmful toxins
  – Dog or cat rejects the food
Fat Oxidation

\[ \text{Antioxidant} \quad R' \quad R'' \]

\[ \text{R=R} \quad \text{Catalyst} \quad T^0, \text{uV, Fe,} \quad *\text{R} \]

\[ \cdot \text{O}_2 \]
Oxidation Reaction

![Graph showing oxidation reaction over time with an IP marker at a certain point.](image-url)
Evaluation of the Use of Oxidized Rendered Protein Meal in an Extruded Pet Food

1. Oxidize rendered protein meal
2. Produce pet food & measure oxidation products
3. Oxidize pet food
4. Measure oxidation products and sensory attributes
Materials & Methods

- **BMBM** (1500 lbs)
  - **BMBM-0** (500 lbs)
    - **BMBM-MT** (500 lbs)
      - 250
      - 250
    - 250
    - 250
- **BMBM-ET** (500 lbs)
  - 250
  - 250
- **CBPM** (1500 lbs)
  - **CBPM-0** (500 lbs)
    - **CBPM-MT** (500 lbs)
      - 250
      - 250
  - 250
  - 250
  - 250
- **CBPM-ET** (500 lbs)
  - 250
  - 250
Materials & Methods - CBPM

[Graph showing PV, meq/kg over time (Days) for CU-PV, CT-PV, CE-PV, CU-AV, CT-AV, CE-AV]
# Cat Food Production

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Diet, %</th>
<th>Diet %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken By-Product Meal</td>
<td>37.80</td>
<td>-</td>
</tr>
<tr>
<td>Meat and Bone Meal</td>
<td>-</td>
<td>51.37</td>
</tr>
<tr>
<td>Rice, Brewers</td>
<td>18.92</td>
<td>14.38</td>
</tr>
<tr>
<td>Corn</td>
<td>18.92</td>
<td>14.38</td>
</tr>
<tr>
<td>Wheat</td>
<td>18.92</td>
<td>14.38</td>
</tr>
<tr>
<td>Beet Pulp</td>
<td>4.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Potassium Chloride</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Monosodium Phosphate</td>
<td>-</td>
<td>0.25</td>
</tr>
<tr>
<td>Salt</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Choline Chloride, 60% Dry</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Vitamin Premix</td>
<td>0.15</td>
<td>0.15</td>
</tr>
<tr>
<td>Trace Mineral Premix</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>DL Methionine</td>
<td>0.10</td>
<td>-</td>
</tr>
<tr>
<td>Taurine</td>
<td>-</td>
<td>0.05</td>
</tr>
<tr>
<td><strong>Ingredient Total</strong></td>
<td><strong>100.00</strong></td>
<td><strong>100.00</strong></td>
</tr>
</tbody>
</table>
Before and After Pet Food Processing
Oxidized BMBM

- PV - Control
- PV - Mixed Tocopherols
- PV - Ethoxyquin
- AV - Control
- AV - Mixed Tocopherols
- AV - Ethoxyquin

Prior To Extrusion
Post Extrusion
Before and After Pet Food Processing
Oxidized CBPM

Prior To Extrusion
Post Extrusion

PV (meq/kg)
AV

PV - Control
PV - Ethoxyquin
PV - Mixed Tocopherols
AV - Control
AV - Mixed Tocopherols
AV - Ethoxyquin
Shelf Life

- 3 kg of pet food/treatment in Ziploc bags
- Accelerated: 40°C; 70% RH
- Ambient: 22°C; 45% RH (ongoing)
Accelerated Shelf Life of Pet Food Produced with Oxidized BMBM (40°C; 70% RH)
Accelerated Shelf Life of Pet Food Produced with Oxidized CBPM (40°C; 70% RH)
Protein in pet foods and nutrition

• Proteins are a point of differentiation in pet foods, a cause for lawsuits, and a major cost factor.
• Higher levels of protein and novel sources are prominent feature in promotions
• Proper selection of proteins can substitute for starches as structure forming elements in pet foods and treats
• Composition and amount of heat processing can affect the nutritional quality of animal based proteins
• Oxidation of animal protein meals may not influence chemical measures of shelf-life profoundly
Questions?