Effects of Particle Size and Feed Form on Broiler Performance

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Introduction

• Overall, feed represents 65-75% of animal production costs.
• If we could improve the utilization of feed then we could lower production costs.

Goodband et al., 2002
Introduction

- One option to improve feed utilization and reduce cost is to reduce particle size to improve the efficiency of digestion.

Goodband et al., 2002
Introduction

- Reducing particle size:
  - Increases the surface area of grains.
  - Allows the feed to have a greater interaction with the digestive enzymes and nutrients.

Feed Technology IV, 1996; Goodband et al., 2002; Parsons et al., 2006
Introduction

• Reducing particle size:
  – Improves mixing and handling of ingredients.
  • Uniform particles have less tendency to separate.
  – Increases pelleting efficiency and quality.

Goodband et al., 2002; Feed Technology IV, 2006
• Research in finisher swine showed an improvement in feed efficiency when pigs were fed a smaller particle size, depending on the type of grain.

Goodband et al., 2002
Model

Particle Size Reduction - Finishing Pig

Goodband et al., 2002
• Poultry diets have shown a mixed improvement in feed efficiency when particle size was reduced.
• The effect of particle size on broiler performance has been thought to be mediated through gizzard function.

Goodband et al., 2002; Amerah et al., 2008; Nir et al., 1995; Engberg et al., 2002
• It has been reported that birds fed pelleted diets have a better feed:gain ratio than those fed mash diets.

• Birds fed coarse grain mash diets have better feed:gain compared to those receiving medium-ground grain mash diets.

Amerah et al., 2008
## Literature

<table>
<thead>
<tr>
<th>Form – Texture</th>
<th>Gain (g)</th>
<th>FI (g)</th>
<th>FCR (g:g)</th>
<th>Gizzard (g/kg of BW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mash – Medium</td>
<td>453</td>
<td>777</td>
<td>1.72</td>
<td>22</td>
</tr>
<tr>
<td>Mash – Coarse</td>
<td>539</td>
<td>877</td>
<td>1.63</td>
<td>20</td>
</tr>
<tr>
<td>Pellet – Medium</td>
<td>834</td>
<td>1271</td>
<td>1.53</td>
<td>11</td>
</tr>
<tr>
<td>Pellet – Coarse</td>
<td>824</td>
<td>1253</td>
<td>1.52</td>
<td>11</td>
</tr>
</tbody>
</table>

Wheat Based Diets, 21 d Cage Study

Amerah et al., 2007
## Literature

<table>
<thead>
<tr>
<th>Grain – Microns</th>
<th>Gain (g)</th>
<th>FI (g)</th>
<th>FCR (g:g)</th>
<th>Gizzard (g/kg of BW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat – 284</td>
<td>888</td>
<td>1357</td>
<td>1.53</td>
<td>9</td>
</tr>
<tr>
<td>Wheat – 890</td>
<td>872</td>
<td>1262</td>
<td>1.47</td>
<td>10</td>
</tr>
<tr>
<td>Corn – 297</td>
<td>823</td>
<td>1191</td>
<td>1.45</td>
<td>9</td>
</tr>
<tr>
<td>Corn – 528</td>
<td>870</td>
<td>1173</td>
<td>1.36</td>
<td>13</td>
</tr>
</tbody>
</table>

Pelleted Diets, 21 d Cage Study

Amerah et al., 2008
<table>
<thead>
<tr>
<th>Micron</th>
<th>Gain (kg)</th>
<th>FCR (g:g)</th>
<th>Breast (%LW)</th>
<th>Gizzard (%LW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>781</td>
<td>1568</td>
<td>1.92</td>
<td>17.3</td>
<td>1.51</td>
</tr>
<tr>
<td>950</td>
<td>1590</td>
<td>1.95</td>
<td>17.2</td>
<td>1.54</td>
</tr>
<tr>
<td>1042</td>
<td>1619</td>
<td>1.93</td>
<td>17.0</td>
<td>1.60</td>
</tr>
<tr>
<td>1109</td>
<td>1566</td>
<td>1.97</td>
<td>17.3</td>
<td>1.61</td>
</tr>
<tr>
<td>2242</td>
<td>1610</td>
<td>2.08</td>
<td>16.0</td>
<td>1.81</td>
</tr>
</tbody>
</table>

Starter Diet 1042 microns
21 day floor pen study
Mash diets

Parsons et al., 2006
Literature

- Benefits to feeding pelleted diets to animals:
  - Decreased feed wastage
  - Reduced selective feeding
  - Decreased ingredient segregation
  - Improved palatability

Behnke, 1994
Benefits of Gizzard Development:

- Improved nutrient utilization
- Improved gut motility
- Prevented pathogenic bacteria from entering the intestine
- Reduced enteric diseases

Nir, et al., 2002; Bjerrum et al., 2002; Ferket, 2000; Engberg et al., 2002; Amerah et al., 2007
Hypothesis

Pelleted feed and reduced particle size improves broiler performance.
Objective

To determine the effect of particle size and feed form on broiler performance.
Materials and Methods
Materials and Methods

• Corn was ground with a 30 hp hammermill equipped with screen sizes:
  – 7.9 mm (20/64”)
  – 1.6 mm (4/64”)

Materials and Methods

- Particle size measurement have been termed fine, small, medium, large, and coarse.
- The standard method for particle size measures the geometric mean diameter \(d_{gw}\) and the standard deviation \(S_{gw}\). 
Materials and Methods

• **Standard Particle Size Analysis:**
  – Split the sample using a riffle divider
  – 100 ± 5 g sample
  – Dispersing agent and sieve agitators were added
  – Run for 10 minutes
  – Measure material on the sieves
Materials and Methods

Dispersing Agent

Ro-Tap

Sieve Agitators
Materials and Methods

Pellet Durability Index
Experimental Design

- 2 x 2 Factorial
  - Particle size:
    - 300 microns
    - 600 microns
  - Feed form:
    - Mash
    - Pellet
<table>
<thead>
<tr>
<th></th>
<th>Mash</th>
<th>Pellet</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>M300</td>
<td>P300</td>
</tr>
<tr>
<td>600</td>
<td>M600</td>
<td>P600</td>
</tr>
</tbody>
</table>
Experimental Design

• The diets were created from a corn-soy basal diet.

• Starter pellet diets were crumbled; grower and finisher were fed as pellets.

• Mash diets were fed as mash throughout the experiment.
## Feeding Program

<table>
<thead>
<tr>
<th>Diets</th>
<th>Actual Amount</th>
<th>Approximate Days Fed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starter</td>
<td>1.5 lbs</td>
<td>0-14</td>
</tr>
<tr>
<td>Grower</td>
<td>6.0 lbs</td>
<td>14-35</td>
</tr>
<tr>
<td>Finisher</td>
<td>6.0 lbs</td>
<td>35-44</td>
</tr>
</tbody>
</table>
Experimental Design

• There were 32 experimental pens of 16 males and 16 females Ross 344 X Ross 708 chicks each.
• There were eight replicate pens for each of the four treatments total.
• Birds were raised on old litter in floor pens.
Experimental Design

• BW and feed intake were recorded at 0, 14, 21, 35, and 44 d.
• FCR was adjusted for mortality (AdjFCR).
<table>
<thead>
<tr>
<th>Ingredients</th>
<th>Starter</th>
<th>Grower</th>
<th>Finisher</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>59.3</td>
<td>67.19</td>
<td>71.47</td>
</tr>
<tr>
<td>Soybean Meal (48%)</td>
<td>35.8</td>
<td>28.15</td>
<td>23.90</td>
</tr>
<tr>
<td>Dicalcium (18.5%)</td>
<td>2.09</td>
<td>1.85</td>
<td>1.57</td>
</tr>
<tr>
<td>Calcium Carbonate</td>
<td>0.97</td>
<td>1.02</td>
<td>1.07</td>
</tr>
<tr>
<td>Salt</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>Vit/TM/Med</td>
<td>0.40</td>
<td>0.40</td>
<td>0.40</td>
</tr>
<tr>
<td>Amino Acids</td>
<td>0.24</td>
<td>0.19</td>
<td>0.39</td>
</tr>
<tr>
<td>Choline Chloride</td>
<td>0.20</td>
<td>0.20</td>
<td>0.20</td>
</tr>
<tr>
<td>Poultry Fat</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
</tbody>
</table>
## Dietary Specifications

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Starter</th>
<th>Grower</th>
<th>Finisher</th>
</tr>
</thead>
<tbody>
<tr>
<td>ME, kcal/kg</td>
<td>2935</td>
<td>3016</td>
<td>3068</td>
</tr>
<tr>
<td>CP, %</td>
<td>23.00</td>
<td>20.00</td>
<td>18.50</td>
</tr>
<tr>
<td>Lysine, %</td>
<td>1.26</td>
<td>1.10</td>
<td>1.10</td>
</tr>
<tr>
<td>Met + Cys, %</td>
<td>0.96</td>
<td>0.83</td>
<td>0.75</td>
</tr>
<tr>
<td>Calcium, %</td>
<td>0.90</td>
<td>0.85</td>
<td>0.80</td>
</tr>
<tr>
<td>Total P, %</td>
<td>0.75</td>
<td>0.67</td>
<td>0.60</td>
</tr>
<tr>
<td>AvP, %</td>
<td>0.45</td>
<td>0.40</td>
<td>0.35</td>
</tr>
</tbody>
</table>
Statistical Design

- Completely Randomized Design
- Proc GLM procedure of SAS
- Means were partitioned by LS Means
- Significance set at $P < 0.05$
Results and Discussion
Feed Processing

- Pellet quality as determined by the PDI:
  - The P300 treatment had a PDI of 90%, 85%, and 88%.
  - The P600 treatment had a PDI of 87%, 83%, and 84%.
Feed Processing

• Particle size of the basal diets:
  – 300 diets had a PS of 261, 263, and 269 microns.
  – 600 diets had a PS of 615, 536, and 519 microns.
Female Body Weight

Body Weight (g) vs. Age (d)

- 300
- 600

Age (d): 14, 21, 35, 44
Body Weight (g): 0, 500, 1000, 1500, 2000, 2500
Female Body Weight

Body Weight (g)

Age (d)

Mash

Pellet

P < .05
Adjusted Feed Conversion Ratio

AdjFCR (g:g)

P < .05
Adjusted Feed Conversion Ratio

Adjusted FCR (g:g)

Age (d)

M600 | M300 | P600 | P300

0-44

P < .05
Gizzards

Weight (% BW)

Age (d)

44

P < .05
Discussion

- There was no difference in BW due to particle size in male and female broilers.
- The BW of the male and female broilers was higher for the pelleted diets as compared to the mash diets.
Discussion

• Treatments P300 and P600 had better AdjFCR compared to the M300 and M600.
• The P300 treatment had the lowest percentage gizzard; the M600 treatment had the highest percentage gizzard.
Discussion

• A smaller particle size did not have a negative effect on broiler performance in pelleted feed.
• A smaller particle size improved feed conversion in mash feed only.
Hypothesis

We accept the hypothesis that pelleted feed improves broiler performance.

We reject the hypothesis that reduced particle size improves broiler performance in a pelleted diet.
Conclusions

• Reduced particle size does not improve broiler performance when birds were fed pelleted diets.
• Pelleted feed improved broiler performance.
• Coarser grain produced larger gizzards.
Questions?