Effect of Die Thickness and Pellet Mill Throughput on Pellet Quality

C.R. Stark
Department of Poultry Science
North Carolina State University
Raleigh, NC
Industry Impact

• Feed Mill Manager
  – Pelleting is the highest cost operation in the mill.

• Nutritionist
  – Least cost formulation can significantly affect both pellet quality and pellet mill throughput.

• Researcher
  – Pellet quality (fines) can affect performance results.
Pellet Quality

Pellet quality is feed manufacturing jargon that describes both the durability of pellets as defined by ASAE 5269.3 and/or percentage of fines at the feeder.
Why Discuss Pellet Quality?

Feed Mill
Good pellet quality is more expensive:
- Lower pellet mill production rate
- Higher energy consumption
- Greater capital investment

Bird Performance
Good pellet quality results in:
- Lower feed conversion
- Increased BW gain
- Less feed wastage
Poultry Research

- Greenwood et al. (2004) reported no difference in feed conversion in diets containing 20 to 60% fines.
- McKinney and Teeter (2004) indicated there was no advantage to produce more than 40% pellets unless pellet quality was in excess of 60%.
Factors Influencing Pellet Quality

- Formulation: 40%*
- Conditioning: 20%*
- Particle Size: 20%**
- Cooling: 5%**
- Die Specification: 15%**

*Nutritionist, **Feed Mill

Behnke, 1994
Effect of Temperature and Particle Size on Pellet quality

Pellet Durability Index (PDI),%

Particles size (P<.01)

Coarse (561 um)  Fine (222 um)

70 C  85 C

Stark, 1994
Effect of Conditioner Setup on Pellet Quality

Briggs et al., 1999
Effect of Temperature on Pellet Quality

![Bar chart showing the effect of temperature on pellet durability index (PDI)].

- 85°C (185)
- 88°C (190)
- 91°C (195)
- 93°C (200)

Unpublished
Effect of Fat Type and Percentage on Pellet Quality

Stark, 1994
Factors Influencing Pellet Quality

- **Formulation**: 40%*
- **Conditioning**: 20%*
- **Particle Size**: 20%**
- **Die Specification**: 15%**
- **Cooling**: 5%**
- **Throughput**: 40%*

*Nutritionist, **Feed Mill

Modified Behnke, 1994
Objectives

Evaluate the effects of die specification and pellet mill throughput have on pellet quality.

• Die thickness (Length/Diameter ratio)
• Material retention time in the die
Materials and Methods
## Diet Composition

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>82.0</td>
</tr>
<tr>
<td>Soybean Meal</td>
<td>12.0</td>
</tr>
<tr>
<td>Minerals</td>
<td>2.5</td>
</tr>
<tr>
<td>Vitamins</td>
<td>0.5</td>
</tr>
<tr>
<td>Poultry Fat</td>
<td>3.0</td>
</tr>
</tbody>
</table>
Pellet Mill Specifications and Pelleting Parameters

- CPM, Model 1112, (30 hp)
- Pellet diameter: 4.4 mm (11/64)
- Conditioner: 46 cm x 122 cm (18x48)
- Conditioner retention time: 20 sec
- Conditioning temperature: 83°C (181)
Treatments

• Die Thickness
  – 29 mm (1 ⅛”), L/D = 6.6
  – 35 mm (1 ⅜”), L/D = 8.0
  – 44 mm (1 ¾”), L/D = 10.0

• Pelleting Rate (production rate)
  – 500 kg/hr
  – 1000 kg/hr
  – 1500 kg/hr
Pellet Die Specifications

Diameter

Counterbore

Effective Thickness (length)

L/ D = \frac{\text{Length}}{\text{Hole Diameter}}

One Step Relief

Two Step Relief
Data Collection

- Pellet production rate (kg/30 sec)
- Pellet mill motor electrical energy consumption (hp)
- Conditioning temperature (°C)
- Hot pellet temperature (°C)
- Pellet durability index (% pellets)
Production Rate

30 sec Collection Period
Pellet Mill Motor Load
Pellet Durability Index (PDI)

- 500 g whole pellets
- Tumble 10 min
- Screen tumbled pellets
- Calculate % of whole pellets

ASAE 5269.3
Experimental Design

- Randomized complete block design
- Three replications per treatment
- GLM procedure in SAS
- Orthogonal comparisons
  - Linear
  - Quadratic
Results
Pellet Mill Efficiency

Die Thickness
- 29
- 35
- 44

Throughput
- 500
- 1000
- 1500
Pellet Durability Index

![Graph showing Pellet Durability Index (PDI), % with linear relationship (P<0.01) for Die Thickness and Throughput.]

- **Die Thickness**:
  - 29: 32%
  - 35: 35%
  - 44: 60%

- **Throughput**:
  - 500: 55%
  - 1000: 41%
  - 1500: 30%
Discussion

• The results of this study confirm the positive effect of die thickness on pellet quality (PDI) and the negative effect of higher production rate.

• Pellet mills should be operated at capacity to achieve maximum efficiency.
Pellet Mill Efficiency Example

- Base
  - 500 kg/hr: 75%
  - 1000 kg/hr: 55%
  - 1500 kg/hr: 40%

- Production
  - 500 kg/hr: 75%
  - 1000 kg/hr: 55%
  - 1500 kg/hr: 40%
Discussion

The data demonstrated that **throughput** should be added to the list of factors that influence pellet quality.

- Feed formulation
- Particle size
- Conditioning
- Cooling
- Die specifications
Conclusions

• Pellet mill operators can improve pellet quality by slowing down the pellet mill and using thicker dies.
• The balance between efficiency and pellet quality remains the “Art” in the pelleting process.
Questions