Most feed for meat birds worldwide is in the form of crumbled or whole pellets. The advantages of pelleting include: Reduced selective feeding, increased nutrient availability, decreased energy required for feed consumption, reduced feed pathogen load, increased bulk density (which lowers trucking cost), reduced shrinkage (because less material is lost as dust), and improved handling in automatic feeding equipment. Together these benefits can dramatically lower live production cost.

If pellet quality is less than favorable, certain management techniques may rectify the problem without incurring large increases in feed manufacturing cost via capital expenditure and energy usage. However, these techniques vary in both effectiveness and cost.

Pellet quality refers to durability, the physical integrity of the finished feed pellet in handling and transport with minimum generation of fines and broken pellets. Typically this is measured as percentage pellets or fines in the feed as fed, or by pellet durability index (PDI), which represents the percentage of pellets by weight that survive a standardized durability test, like the Kansas State University "tumbling can", Holmen tester or Kahl tester.

Pellet quality varies among the birds used for meat production. Pellet quality is especially important with ducks, where the mill may seek PDI of 96% to achieve optimum bird performance. The PDI target for turkeys is often 90% and the target for broilers is typically 80%.

Pellet quality affects bird performance

In 1990 Zatari and colleagues compared broiler performance on two feeds with different pellet quality. One feed was 75% pellets and 25% fines, the other was 25% pellets and 75% fines. Final body weight and cumulative feed conversion was higher in the group fed 75% pellets (see figures Pellets effect on broiler body weight and Pellets effect on broiler feed conversion). The improved bird performance translated to a benefit of $0.021/bird, based on feed cost of $140 per ton and feed manufacturing cost of $5 per ton (Scheideler, 1995).

Compared with broilers, turkeys are more adversely affected as the proportion of fines increases in the feed. Pellet quality is critical with turkeys because the birds spend more time on feed, thus sub-optimum pellet quality causes more feed wastage. In 1990, using toms from 7 to 18 weeks of age, Brewer and associates demonstrated a 7-point and 10-point improvement in feed conversion from feed with 10% fines compared to feed with 50% fines (see figure Pellet quality’s effect on turkey feed conversion ratio).

Duck performance is more sensitive to pellet quality than either turkeys or broilers. When a duck consumes mash feed, a sticky paste forms on its bill. The caking discourages optimum feed consumption and, when the duck washes its bill, feed wastage increases (see figure Pellet quality’s effect on pekin duck feed conversion ratio). In 1986 Dean showed duck feed conversion could be improved by 2.8% by decreasing the amount of fines in the feed from 16% to 0% (see figure Pellet quality’s effect on pekin duck cumulative feed conversion ratio).

Adjustments to improve pellet quality

Ingredients have a very significant effect on pellet quality. Certain types of starches and proteins have natural, inherent, binding capabilities. Ingredients’ fiber, mineral and fat content also affect pellet quality. Wheat, barley and canola meal, for example, contain inherent binders that form physio-chemical bonds.
Cost-effective pellet quality for meat birds

Pelleting’s effect on pckin duck cumulative feed conversion ratio.
(adapted from Dean, 1986)

<table>
<thead>
<tr>
<th>Feed/Gain</th>
<th>100% Mash</th>
<th>100% Pellets</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.00</td>
<td>2.75</td>
<td>2.5</td>
</tr>
<tr>
<td>2.50</td>
<td>2.50</td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>2.00</td>
<td></td>
</tr>
</tbody>
</table>

Pellet quality’s effect on turkey feed conversion ratio.
(adapted from Brewer et al., 1990)

<table>
<thead>
<tr>
<th>Feed/Gain</th>
<th>50% Fines</th>
<th>10% Fines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter</td>
<td>2.54</td>
<td>2.60</td>
</tr>
<tr>
<td>Summer</td>
<td>2.47</td>
<td>2.5</td>
</tr>
</tbody>
</table>

During processing, resulting in higher pellet quality. However, outside Europe and Australia, where wheat and canola meal-based feeds are common, poultry feeds typically contain high levels of corn and soybean meal, which are low in inherent binders.

In any case, most diets for meat birds are formulated by least cost or optimal cost methods that generally do not consider ingredients’ “pelletability”. But other management techniques offer cost-effective means to improve pellet quality. For feeds with a high coarse grain content, therefore, the focus should be on proper management of ingredient particle size, mash conditioning, pellet die performance and fat (see tables How pelleting factors influence pellet quality and Estimated cost of implementing various techniques to improve pellet quality).

**Choose a practical particle size**

Grinding grains to a fine particle size enhances pellet quality. A smaller particle has a larger surface area that allows heat and moisture to penetrate more quickly to the core of the particle during conditioning. This larger area increases starch cell rupture and gelatinization. As a practical matter, however, optimum particle size for pellet durability in corn-soy poultry diets is probably in the range of 650-700 microns.

In 1992 McElhinney showed that though reducing corn’s particle size to 500 microns from 700 microns improves pellet quality, twice the grinding energy is required to achieve the smaller particle size. If you are making poultry feed, consider conducting your own tests to determine the optimum particle size to meet your energy use and pellet quality expectations.

**Cold mash moisture**

In recent research from Kansas State University (K-State) Greer and Fairchild demonstrated that moisture content of the pre-conditioned or cold feed mash has a linear effect ($R = 0.97$) on pellet quality. New moisture monitoring and control technology allow the moisture to be added at the mixer, which can be particularly beneficial when using low-moisture grain.

Using a 42-day broiler growth assay, in 2000, Beyer and colleagues reported that using moisture control technology increased PDI from 61.7% to 87.3%. Feed conversions also improved by 5 points on a dry matter basis from 3 to 6 weeks of age and 2 points from 0 to 6 weeks of age.

However, the K-State researchers noted disadvantages too. Adding moisture in the mixer increased weight per volume of feed, which would hurt transportation efficiency. The birds also experienced poorer feed conversion on an as-fed basis, which suggests that the added moisture negatively affected nutrient density. While moisture control technology shows promise as a technique to improve pellet quality, field trial data are needed before this technology can be adopted by the poultry industry.

**Steam quality’s importance**

Corn-based poultry diets require good mash conditioning—the application of moisture and heat over time—in order to activate the inherent binders that make a high quality pellet. For example, proper conditioning opens starch cells in raw corn, disrupting the organization of amylase and amylpectin molecules which reform around other ingredient molecules in a process known as gelatinization. Free amylpectin generated from conditioning is primarily responsible for the improvement in pellet quality.

Adequate mash conditioning must take place during a short period—no more than a few minutes in a conventional steam conditioned pelleting system or as little as 30 seconds in a “super conditioner” or expander system. High quality steam helps to optimize the effect of heat and moisture on the feed mash.

Steam quality is defined by the amount of vapor divided by the mixture of free water and vapor. When steam has vapor concentration near 100%, it is called “saturated steam”. When steam has free water and vapor, it has vapor concentration less than 100%, and is considered “wet steam”. In 1995 Turner suggested a rule of thumb when saturated steam is used, feed mash temperature increases approximately 29°F (16°C) for every 1% increase in mash moisture. If steam quality is 80% (wet steam), mash temperature may only rise 24°F (13.5°C) for every 1% in moisture. So poor steam quality can reduce conditioning temperatures by 11-20°F (6-
Fat application—where and how

Where and how fat is applied in the feed manufacturing process makes a big difference in pellet quality. Field experiences indicate that adding more than 2% fat in the mixer causes a very rapid—perhaps exponential—decline in pellet quality. High concentrations of supplemental fat in the mash tend to reduce the friction between the feed, roll, and die. This prevents the roll from pushing the feed through the die.

By contrast, a modern post-pelleting application system can add fat at a high rate of accuracy (0.5%) without compromising pellet quality. Fat can be applied at the die, although this can cause housekeeping problems downstream, especially in the pellet cooler. Currently, there is a preference to add fat just before load-out, using modern pressurized spray and non-pressurized, rotating disk coating systems. In such downstream liquid application systems there is less mess. Fat application may also be combined with the application of enzymes and other heat-sensitive microingredients.

While fat-at-the-die systems typically apply no more than 2-3%, at loadout it is common to add fat at rates of 6-8%. This technology allows an adequate time for fat absorption into the pellet. Fat-at-the-die systems also have the problem of heat and moisture simultaneously escaping from the pellet.

Do not overlook the die

Maintaining optimum die performance is vital for manufacturing high quality pellets. Some of the common problems that affect pellet quality include die face wear, rollover, pitting and corrosion. These problems compromise pellet quality by decreasing die effective thickness and die hole compression ratio. If pellet quality declines over time without other apparent cause, then consider reconditioning or replacing the die.

Reconditioning a pellet die can provide additional production life—up to 65,000 tons for broiler feeds—at significantly less cost than replacing a die. However, bird performance from optimum pellet quality must be balanced with the cost of exchanging the die. For example, because duck feed manufacturers need higher pellet quality, they recondition dies about three times more frequently than broiler feed manufacturers. Frequent pellet mill lubrication, upstream tramp metal removal and careful roll gap adjustment can help minimize die problems.

Investing in bird performance

From the standpoint of cost-effectiveness, steam quality, fat application, and die maintenance probably offer the most benefit in optimizing pellet quality for meat birds. Other feed milling alternatives can also significantly improve pellet quality, but these may require new equipment or other modifications that increase production cost.

Wheat and wheat co-products have inherent binding capacity and can improve pellet quality. So can commercial pellet binders. However, manipulating a diet formula to improve pellet quality can reduce flexibility in least cost formulation and may prove costly on a long-term basis.

To optimize pellet quality cost-effectively, a poultry feed manufacturer should be sure to put a priority on managing steam, fat and pellet dies. Returns from improved bird performance must exceed the increased cost of feed production to justify major changes in diet formulation or the feed manufacturing process.

References


