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QTI™ ANIMAL HEALTH & NUTRITION

How Does Your DFM Hold Up During Pelleting?

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Key Points:

- Manufacturing advances allow new ingredients in pelleting
- Pelleting is becoming more economical
- Pelleting processes impact the survivability of DFMs
- CALSPORIN® has extremely high survivability rates when pelleted*

Pelleting Background

The pelleting of animal feed is certainly not a particularly new concept. However, there are many new, and constantly evolving, lists of ingredients and additives that are showing up in feed formulations. From the additive perspective, ingredients like vitamins and medications have been used in pelleted diets for quite some time, and we have generally learned how to manufacture them to ensure survivability. Biological additives, things like enzymes, yeasts, and direct-fed microbials (DFMs) present similar viability challenges, but in many cases are still new enough that these challenges have not been overcome. Understanding the pelleting process can help us to learn how to improve the stability of these new additives and, in the meantime, how to process them in order to achieve the best possible return.

Recent History

In recent decades, there has been a great deal of evolution in equipment, technique, and controls technology related to the pelleting of animal feeds. Generally, improvements to the process have been made to increase production rates and capacities, improve finished feed quality, and to improve the ability to handle new ingredients, e.g. by-products like DDGS.

Feed Markets

In the United States a large amount of feed is pelleted every year. Roughly 50% of the total feed volume produced is estimated to go to poultry, with a large proportion being pelleted feed for broiler production. The next largest consumers of feed are swine, and based on the region of the country they may be fed either mash (Midwest) or pellets (mid-Atlantic.) However, with an increase in feed ingredient prices, pelleting is becoming more economically feasible even in areas where mash feeds have typically dominated. To these large groups we can add pelleted commercial feeds for horses, cattle, sheep, rabbits, etc.

Benefits

Pelleting provides a number of benefits, related to both material handling and animal performance. Pelleting feed generally improves flowability and increases bulk density, both of which can impact transportation logistics and on-farm storage and feeding. Pelleting also prevents ingredient segregation and feed wastage and reduces the time and energy required for consumption. Each of these items has a positive impact on animal performance, typically in the areas of feed efficiency and bodyweight gain.

Pelleting Process

Production Rate

The production rate, or throughput, of a pelleting system is controlled by the feeder. This is usually a simple screw conveyor controlled by a variable frequency drive (VFD) that can be sped up or slowed down as required. The production rate will have an effect on pellet quality and energy efficiency, but will typically affect additive survivability only indirectly, based on its impacts on down-stream processes.

Steam Conditioning

In this piece of equipment, live steam is added directly to the mash feed and the two are mixed. Conditioners may have anywhere from one to three “passes,” with single- and double-pass designs being the most common. Adjustable paddles attached to a rotating center shaft move the product through the conditioner, with the pitch of the paddles being set to achieve an optimum fill level and retention time. Typical ideal conditions are temperatures around 185°F (85°C) and 16.5 - 17.0% final moisture, with an average retention time of 30 - 45 seconds.

It is this environment that has the greatest impact on biological additives such as DFMs. Degradation is a function of time, temperature, and moisture, and unfortunately the best conditions for efficiently producing good quality pellets are at the upper limits of each. Thus, there can be some contradiction between maintaining survivability of the product and producing the highest quality feed.

The newest technologies in this area revolve around increasing the retention time. Referred to as "long-term conditioning," these processes take numerous forms, and may pose significant hurdles to the survivability of heat sensitive products.

Pellet Die

The pellet die is the mechanical component that is responsible for shaping the pellet into its final form. For most pellet mills the die is a ring that travels around a fixed set of rolls. Mash feed is pressed between the rolls and the inner surface of the pellet die and is extruded through the die holes from the inside out. Pellet dies can vary in their metallurgy, with processes creating dies of different strengths and ideal application. Die holes are not typically one diameter from the inner face to the outer surface, but often have drilled reliefs in order to create a specific "effective thickness" and make the die function more efficiently. The "effective thickness" divided by the die hole diameter is a parameter known as the L:D (length:diameter) ratio. Higher ratios typically lead to improved pellet quality because of higher friction and compression effects. Important to additives such as DFMs, the friction that occurs as material passes through the die adds heat to the already conditioned material. Also, throughout the day the die acts as a heat sink, gathering energy from the hot mash, until the die itself is significantly warmer than the temperature of the incoming conditioned mash. Combined, these two effects often mean that the pellets leaving the pellet die are hotter than the conditioning temperature, with the difference being denoted as the ΔT (hot pellet temperature – conditioning temperature = ΔT.) Typically, a higher L:D ratio will lead to a greater ΔT, and may impact additive survivability, especially if the original conditioning temperature is already near the upper limit of the stability range.

Cooling

Though often overlooked, cooling can have a major impact on the survivability of feed additives like DFMs. There are two types of coolers commonly used today, horizontal and counterflow. Horizontal coolers use connected pans to move the material laterally while allowing ambient air to move upwards through the bed of pellets. In counterflow coolers, the pellets are cooled in a single chamber.

About the Author

Dr. Fahrenholz earned his B.S. in Feed Science and Management and an M.S. and Ph.D. in Grain Science at Kansas State University. His areas of interest include feed processing technology as it relates to improved manufacturing efficiency and finished product quality, the impact of feed processing on animal performance, and the regulatory environment impacting the feed manufacturing and related industries. Dr. Fahrenholz joined the Prestage Department of Poultry Science at North Carolina State University in June 2012 as a Post Doctoral Research Scholar.

Rather than conveying the pellets to maintain a constant bed-depth, cooled pellets are discharged from the bottom of the chamber when a max-fill indicator is activated. Proper cooling is essential to finished feed quality and stability (i.e. to prevent molding), and should be closely monitored. However, if the cooling process is not adequately controlled, and feed remains hot for an extended period of time, this may certainly have a negative effect on DFM survival. As stated previously, degradation is a function of time, temperature, and moisture, and so having DFMs exposed to hot, moist conditions for any longer than necessary is probably not ideal.

Post Pellet Liquid Application (PPLA)

In most cases, PPLA equipment probably won't directly impact an additive's chances for survival, but are worth noting as a major part of some pelleting systems. Most commonly these systems are used to apply fat after pelleting. Fat is pulled out of the pelleted ration to increase die friction, and thus pellet quality. Of course, this can potentially increase the ΔT and negatively impact heat-sensitive ingredients. PPLA systems can also be used to apply other liquids, and so provide an alternative addition site for other ingredients, most typically enzymes, that may not be heat stable.

Summary

In pelleted feeds, the greatest impact on DFMs is going to be the combination of time, temperature, and moisture. Unfortunately, feed manufacturers are typically trying to achieve parameters to promote feed quality and production efficiency that may be anything but ideal for DFM survivability, so there will be an understandable hesitancy to change them.

* A note from QTI... We thank Dr. Farenholz for his article. After reading his information on pelleting, you may conclude that adding DFMs to the pelleting process is a little risky due to the survival of the spores. That's where CALSPORIN® comes in. CALSPORIN is known for its extremely high viability rate. If you are wanting a pelleted DFM, CALSPORIN is the obvious choice—not only due to the survival rate, but because of the results you'll get in weight gain and health benefits.