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SPECIAL REPORT

Advances in Extrusion

As manufacturers continue to explore new formulations, extrusion equipment is adapting to meet a variety of novel production needs.

by Joanna Cosgrove

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Extrusion is the most common large-quantity pet food and treat manufacturing process, providing a cost-effective method of creating nutritious, safe products for companion animals. All extrusion processes require equipment that dovetails with a manufacturer's unique product needs. As formulas for extruded pet foods and treats become more complex and nutrient-dense, some manufacturers are opting to forego the traditional high-heat extrusion process for a cooler process that preserves delicate bioactives.

Dave Albin, Ph.D., applied nutrition technologist, Insta-Pro, Urbandale, Iowa, likened extrusion equipment to being the "heartbeat" of a dry pet food company. As such, a reliable, easy-to-use system decreases the inefficiencies and expenses of downtime. To gauge the reliability of an equipment supplier, it's a good idea to find out how long that supplier's customers have been able to make products using their equipment. Good equipment should last decades.

Simplicity is also best. "The complexity in an extrusion system increases the risk of mechanical failure and downtime or, at least, increases the requirement for highly-technical personnel to avoid downtime," Albin said. "Ease of operation—and all expenses related to maintenance and daily operations of the extruder—must be evaluated and calculated, respectively."

Albin also recommends brands honestly assess how well a potential extruder will meet the needs of their unique production line. "All of the supporting equipment must work reliably and effectively along with the extruder, and the extrusion process should even enhance the functioning of other equipment as well," he said. "For example, pet food kibble must be dried in order to have an extended shelf life. Different types of extruders produce kibble with more or less moisture, and those that operate with less moisture, and also free up as much moisture as possible during extrusion, will make drying easier."

Just as extrusion equipment should have a long and durable lifespan, so too should the relationship between equipment suppliers and the manufacturers using their equipment. "Aside from supplying the basics, such as parts and service, they should also have people who understand other aspects of operating a pet food plant, such as typical pet diet formulations and product types, quality systems, food safety issues, and at least some concepts related to regulations," Albin said. "Extruder companies should come to be a helpful resource to their clients [and] when necessary, they should be able to refer a pet food manufacturer to another company that can help solve problems."

Given the interplay between formula attributes and the demands of the extrusion process, it's understandable that pet food manufacturers will likely

have certain extrusion-related concerns. Ed Beecher, senior sales and process engineer, food and pharmaceutical industries, Coperion, Salina, Kansas, said the top concerns of pet food manufacturers vary greatly, from ways to boost production runs, simplify sanitation, control ingredient costs, reduce changeover times between runs and increase the ability to produce a variety of product types and sizes—all with an emphasis on cutting costs but improving overall food safety.

"Automation of the complete process is a key trend in pet food manufacture from raw ingredient receipt and transfer, including various pneumatic transfer options, batch weighing techniques, and continuous feeding methods, all the way to the extrusion and packaging steps downstream," Beecher stated. "All automated equipment designs will emphasize process and product safety, as well as options in process design for minimizing overall down times for product changeovers and cleaning."

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Extruder suppliers are also working to make sure their technology keeps pace with formula innovations. Beecher said a quality equipment manufacturer will be active in process and product development (e.g., high-moisture meat analog product development).

Some of the basic equipment innovations and new system options to improve product quality and output include improvements in cooling die technologies, particularly for the high-moisture texturized proteins used in wet and canned pet food products; the use of both single-screw and twin-screw extrusion technologies within a single process running in tandem, to create a unique pet food product; innovations in devolatilization technologies; and improvements in method of feed and feeder technologies of raw ingredients to the extruder (especially as relates to difficult-to-feed additives that may be very light in bulk density, or cohesive with capabilities to cause bridging in the feeder hopper).

To assist with difficult flowing products, Coperion K-Tron developed ActiFlow™, a real-time vibration device mounted externally to the feeder (with no product contact), and tied directly into the loss-in-weight signal. "If the feeder experiences a bridge or rat-hole and little or no material is being sent to the screws, the ActiFlow vibration is activated and the bridge breaks," Beecher explained. "After the weight signal is stable again, the vibration is deactivated, preventing additional packing that may sometimes occur with traditional vibration devices. In other words, it is a 'smart' real-time vibration device activated clearly by the loss-in-weight signal."

Albin noted extruders operate within certain well-defined parameters and physical constraints, so most extrusion companies should be able to explain

which equipment is the best fit for specific product formulating needs. "Grain-free formulas are challenging because they easily contain inadequate starch levels for binding the kibble together," he said. "An extruder company could discuss alternative ingredients that may enable binding, while being acceptable to the consumer."

"In addition, extrusion operating parameters that affect binding, for example, should have been investigated and available for customers to optimize product formation," he added. "Operating parameters include extruder temperature; configuration and operating speed of the internal extruder barrel components; rate that ingredients are fed into the extruder; size, shape and quantity of die openings; and temperature and mixing speed within the preconditioner (before extrusion); to name a few."

Gauging FSMA's Impact

In 2011, President Obama signed into law the Food Safety Modernization Act (FMSA) to ensure safety of the U.S. food supply for humans and animals alike. Following a flurry of pet food recalls, in 2013, FDA proposed a new rule establishing higher processing standards for animal feed and pet food manufacturers. Among the many aspects of the manufacturing process, the standards impact is the proper cleaning and maintenance of processing plants and equipment.

"From an equipment and systems supplier [standpoint], FSMA has had a huge impact," said Beecher. "It is important to choose an extrusion system supplier who not only understands the requirements of FSMA from the equipment design perspective, but who can also help to educate the pet food manufacturers as to which features in the process and equipment design will help to ensure food safety through cleanability and lack of contamination.

"In general," he continued, "the ability to minimize any risk of contamination—as well as minimize downtime for cleaning and product changeover by including proper design techniques in the extruder and material handling equipment—can make a huge difference in the process, product safety and overall process efficiency."

Albin agreed, and added that the importance of the extruder as a critical control point (CCP) in a hazard analysis and critical control points (HACCP) plan has increased. "Extruders cook and shape kibble under high temperature and pressure conditions," he said. "As such, an extruder company should be able to present data indicating the degree to which their extruder can pasteurize or sterilize pet food products. Quality and food safety systems are key to FSMA, and extruders play into these systems very well."

Less Heat, More Nutrients

Extrusion is most commonly accomplished using a high-heat process that can degrade sensitive ingredients. While post-extrusion applications, such as

enrobing, are one way to preserve the nutritional integrity of some ingredients, a handful of companies are branching out to take the concept of extrusion in new directions.

Boulder, Colorado-based In Clover uses a unique cooler-temperature extrusion process to help preserve the innate nutritional properties of its line of chewy, functional, canine and feline reward treats.

"Extrusion is a hot process in its normal form, heating up to about 265 degrees, and it can be harsh for fragile active ingredients," said Rebeca Rose, the company's president and product developer.

Rose, who has a background in pharmaceutical biochemistry, spent seven years researching and tweaking her company's products, which she says are actually supplements in treat form, to ensure they have the nutrient levels they are formulated to have from start to finish.

> Since FSMA, the importance of the extruder as a critical control point (CCP) in a hazard analysis and critical control points (HACCP) plan has increased.

In Clover's manufacturing process begins with mixing ingredients that are allowed time to activate together without the influence of heat to speed the process. They are then put through the extrusion process, where the ingredients are mixed together and taken through a forming unit. The products are transferred, unheated, to a mold that shapes the product into clovers, which are then run through a chill tunnel, cooled down and transferred immediately into packages that feature an oxygen-impermeable inner liner to further maintain product integrity and render refrigeration unnecessary.

"The reason for our cautiousness with timing and blending during this process is because we don't want to destroy any active vitamins, minerals and botanical ingredients, and beneficial microorganisms," Rose said. "Our cold extrusion backs up to the very beginning of the process, and there's testing thorough to ensure there are no bad microorganisms, salmonella or pathogenic organisms present anywhere.

"It's all done in a very clean room with very clean equipment," she explained. "There's an air handling system that holds the room under negative pressure so no air comes in the room from outside. When the extrusion process is complete, we put the product right into its package so it's not left out at all."

In Clover's process may seem complex, but Rose believes top-quality products deserve the benefit of solid research and production standards. "During the course of our research, we did a lot of work on water activity and discovered a way to take the water activity in the product down, which is important because if your product has a lot of moisture that's not being flashed off with high heat, it invites microorganisms into the product," she said.

In Clover's manufacturing is done with a partner company, but it's not your usual partnership. "Rather than turning a raw idea over to a contract

manufacturer to pull together, we completed the research and formulation work, sourced the ingredient suppliers and we worked with our contract manufacturing partner," Rose said. "It's a very accessible, transparent relationship and it really helps make sure all aspects of our production go smoothly."

Unconventional processing has also proven to be the best route for Blackwood Pet Food LLC, a Lisbon, Ohio-based subsidiary of Ohio Petfood. According to Matthew Golladay, the company's vice president, slow processing for optimum starch conversion is key. "If you run your product through your extruder as hot and as fast as you can, your product is probably fine—but we believe if you slow down, you can make it better," he said. "It's not just about what you make the food with, it's about how it's made. Just like grandma's pot roast, if it's cooked all night, it falls apart and tastes great; but if it's cooked fast, it's like shoe leather."

With the help of Kansas State University, the company funded a study to put its Slow Cooked Pet Nutrition™ theory to the test. The researchers confirmed that when slow cooked, high-starch conversion food was fed to chicks, the chicks grew faster, retained more weight and had the least amount of stool.

A comparable dog study recently concluded with similar data. "Slow cooking is a real thing," commented Golladay. "If a formula is more thoroughly cooked, the animal can take the same amount of product and take in more energy. In an animal that's full grown, they can take in more nutrition and not have to eat as much."

Golladay said his company's slow cooking and extrusion process is a little more time consuming than most. Depending on the ingredients of each kibble, extrusion runs each require tweaking. "The more oils and fats, the faster it'll run, which requires tweaks like plugging die holes so there's enough back pressure to create a good cook," Golladay stated.

In the end, the company may not be the pinnacle of manufacturing efficiency, but Golladay firmly believes the product trumps the process. "Part of the reason Blackwood is not an inexpensive brand is because of our ingredient quality and our slower process, which all results in a high-quality product," he said. "Our lower heat process slows down the extrusion process, making it less efficient, but our goal isn't to make the cheapest pet food, it's to make the best food we can." ❑

Joanna Cosgrove is a Pennsylvania-based writer who has covered the vibrant and wide-ranging facets of good health and nutrition since 1998.