The Extru-Technician

EXTRU-TECH

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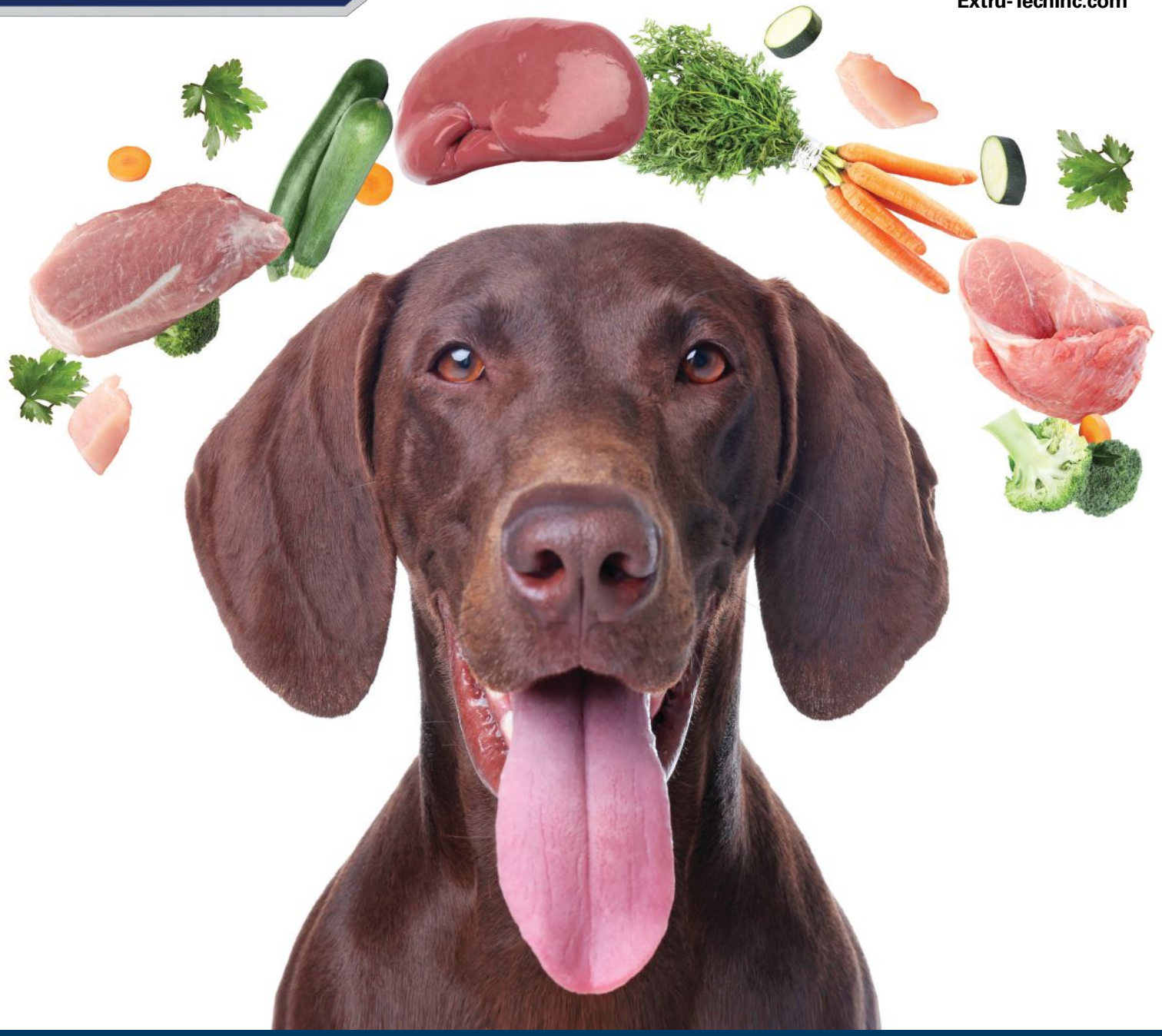

The Process Impact of SPECIALTY PROTEINS IN PET FOOD

WELCOME LETTER

WELCOME, AND THANK YOU FOR YOUR CONTINUED INTEREST IN THE EXTRU-TECHNICIAN.

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» In this issue, we will focus on specialty proteins and their impact on the complete pet food manufacturing process. Extru-Tech's Research & Development Director, Will Henry, will discuss the various specialty proteins used in the industry today and the ongoing challenges these proteins may have on the entire production process. Specifically, he will touch on the impact of proteins on preconditioning and the interaction of proteins with the die—and what those mean for your production process.

As always, we hope you find this issue of *The Extru-Technician* informative as we share our expertise and experience regarding specialty proteins for pet food and the effect they can have on the overall product and manufacturing process.

Please continue to share your comments and thoughts with us; we appreciate the feedback and look forward to offering solutions.

Sincerely,
Rachel Cardwell
Marketing Director

The Extru-Technician brought to you by **Extru-Tech, LLC**

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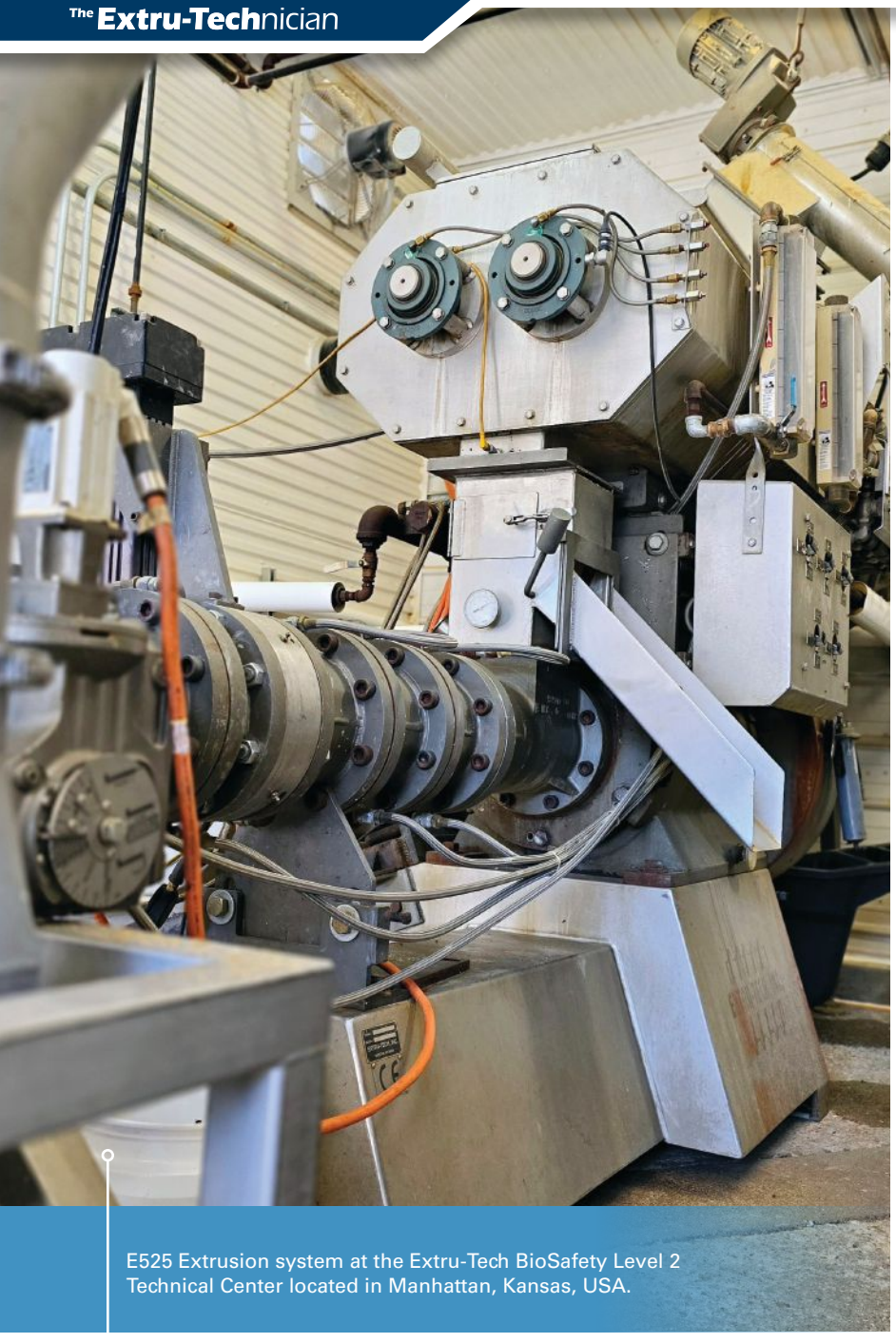
The Process Impact of SPECIALTY PROTEINS IN PET FOOD

Switching proteins requires a full understanding of their attributes

By Will Henry, Extru-Tech Research & Development

» At our pilot facility in Manhattan, Kansas, we regularly execute research and development projects for internal and external clients. In the past year alone, we conducted projects for 50 external clients, with more than half focused on validating novel ingredients for the industry and about 45 percent concerning new pet food or treat formulas.

Proteins have been a major focus of that research. In the four years ending in 2023, the number of pet food projects dealing with proteins increased from 5 percent to 25 percent. Some of them are brand new ingredient streams like novel marine-sourced peptides, while others are more familiar proteins that have never been fully investigated for binding ability, durability, or strength and hardness.



E525 Extrusion system at the Extru-Tech BioSafety Level 2 Technical Center located in Manhattan, Kansas, USA.

This article explains the process that we go through to help clients:

- Develop, vet, and verify the processing and handling of the protein ingredient
- Understand how the protein ingredient impacts each step of production
- Understand how the protein ingredient interacts within a given diet

These steps are necessary in getting the ingredient ready for the commercial production stream.

Different Proteins Have Different Properties

Our process starts with a strict interrogation of the raw material source stream. Before using a new ingredient in pet food, manufacturers must learn how to process and handle it so it can be validated by AAFCO. Novel proteins require extensive study to understand the functionality of that component in the animal and to ensure it has no adverse effects. Verifying the process for incorporating a novel ingredient into recipes is just as important, because it will affect other ingredients and the nutrients, texture, and palatability of the final product.

Animal proteins such as fresh and dehydrated muscle and organ meats, plus meal and stabilized slurries, have long been the mainstay protein sources for pet foods. These include traditional options like beef, pork, poultry, and fish, as well as less common options like kangaroo and invertebrates. These proteins often come with fat, which can serve as lubricants in the production process, and organ meats generally have good binding properties.

Other animal-sourced proteins include gelatin, collagen, eggs and egg-derived proteins, whey protein concentrate, casein, and caseinate. All of these can double as binders, although they may work in very different ways. We'll discuss these differences in more detail later in the article.

Chicken fresh meat slurry used for a premium pet diet.

Newer protein sources have also been made possible thanks to improved technologies, including peptides, cell-cultured meat, and albumin and whey that are produced through bacterial fermentation rather than from eggs, plasma, or milk.

Finally, vegetable proteins play a big role in pet food, particularly pea and soy proteins, glutens, and rice protein isolates and concentrates. A newer entry to the market is barley protein concentrate. Lentils, lupin, chickpeas, and fava beans are increasing in popularity.

Switching Proteins Affects Raw Material Blending

Changing out one protein for another on the ingredient deck affects the entire production process. It may lead to shifts in energy and water consumption, as well as the cooking, extrusion and drying processes. But the tweaks to your process may need to begin even before cooking.

Let me give you an example. Recently, I worked with a customer that was having difficulty reaching their target density, and the motor load was keeping them from hitting capacity rates. They were blending all the materials for that

Sorghum-based protein, with a different die configuration to change the appearance and texture of the product to emulate a natural meat source.

Extruded wheat-based protein to give the appearance of a natural meat product.

ingredient deck into one hopper, then grinding it once, all at the same level. This caused problems because among their ingredients were dried peas, which need a higher grind level because they have a hardness and oil content that make it more difficult for moisture to enter and denature, or cook, the proteins. The grind level also was inhibiting gelatinization of the starch in the peas, which is crucial to the expansion process.

In short, the density was high because the grind level on the peas did not allow for timely absorption of thermal energy into the product, which in turn led to insufficient cooking or expansion of the product. The immediate corrective action to obtain the target density (and achieve appropriate cook levels) was to slow down the dry feed rate, resulting in additional dwell time in the preconditioner and extruder to facilitate the appropriate level of cook and achieve target density.

Even within a similar class of proteins, characteristics can vary significantly. For example, whole spray dried egg is about 50 percent fat, so in large amounts it can coat the screens and reduce throughput on the hammer mill. On the other hand, the engineered egg-based product OvaBind is higher in protein and lower in fat, so it does not cause the same issues.

As for newer sources like peptides and cultured meats, the jury's still out on the best way to process them. We do not know yet if these will be incorporated as a stabilized liquid that we pump into the preconditioner in situ, as a powdered dry ingredient, or some other form. There are speculations out there, but it's too soon to tell.

The Impact of Proteins on Preconditioning

The impact of proteins on preconditioning comes down to temperature and time. Every protein has a specific amount of thermal energy required to

denature it—it is not a one-for-one replacement. For example, if a machine is running ten tons per hour and you decide to swap out corn gluten meal for pea protein, you need to improve cooking efficiency at the preconditioner or gain more cooking time by reducing your rates. That's because the pea protein takes more energy to cook than corn gluten meal.

The theme of temperature and time comes up again when using proteins as binders. Binders activate in different ways, with some being hot-set binders and others being cold-set binders. Like the name says, hot-set binders begin to set when they are hot, while cold-set binders are activated with heat but do not set until after they begin cooling.

Eggs are among the hot-set binders. It is important to carefully control the temperature and timing, because if they reach high temperatures too quickly, they will begin binding the mix before it's ready. I compare the result to a taffy-pulling contest in your pre-conditioner—and no one wants that. To get the right specifications of hardness, durability, or porosity, the pet food manufacturer must consider and control where and when in the process the binder will activate.

Another case study will illustrate this point perfectly. I was working with a client who had poor durability coming off the die. When they ran this product, their yield loss was substantial. It turned out that the recipe was high in egg protein, which should have been great for binding. But they were fully cooking that egg in the preconditioner and leaving nothing for the extruder to work with. Once they cooked that egg, it lost all further binding ability. That explained why the product fell apart.

The cold-set protein sources like gelatins pose different issues. They don't start to bind until they get below about 145°F (the exact temperature will vary depending upon source and bloom). So, if you want to solve a problem with binding at the extruder with a recipe that comes out of the die at 220°F, your answer is not gelatin. It will only assist with durability after the product gets to the cooler.

The other points to consider revolve around maximum process temperature and pH levels. High temperatures will greatly impact the binding strength, levels of which vary depending upon the source. And most of these specialty binders begin to lose binding strength if the pH drops below 3.5.

The Interaction of Protein with the Die

At the die, the main considerations are the open area, mechanical energy, and thermal energy. In this section, we discuss how those different components are changed to accommodate different proteins.

Vegetable proteins such as soy, lentils, peas, chickpeas, and lupins need more energy to activate than animal proteins, especially fresh animal proteins. Extreme flexibility at the extruder is required to ensure the vegetable proteins form a functional part of the kibble's structure, as well as function within the animal in terms of

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digestibility. To properly activate these vegetable proteins, the technician can:

- **Reduce the die area.** This will increase the pressure, putting more energy into the product. However, the technician will also need to step up the velocity (and energy usage) or accept a reduction in capacity.
- **Increase mechanical energy,** or the shearing action being put into the product.
- **Adjust thermal energy.** With fresh animal meats, steam may be avoided because they bring a lot of water into the system on their own. On the flip side of that, the vegetable-based proteins benefit from steam. Besides helping to deliver more thermal energy into the proteins, steam acts as a lubricant, reducing motor load and optimizing energy consumption.

As you can see, switching proteins is not a speedy process. It has effects on raw material blending, preconditioning, and extrusion that must be fully considered and tested.

The differences do not stop there. In a future issue, we will discuss the impact on the drying process and the functions that different proteins bring to the product. The Extru-Tech Single Screw Cooking Extruder, with the Energy Management Valve, the Mid-Barrel Valve, and its own scientifically validated SSOP, is a natural partner to the Aseptic Dual Preconditioner.

Learn more about creating specialty meat-add products with the Next Generation Single Screw Extruder in the next issue of *The Extru-Technician*!

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Harnessing the ability to cost effectively produce dynamic products that drive demand from a market perspective is a trait found in the most successful brands in the industry. With an Extru-Tech Extrusion System, you can cost effectively deliver high margin Premium Petfoods as well as Sub 1 Millimeter Sinking Aquafeeds on the same system.

KEY BENEFITS THAT DRIVE PROFIT TO YOUR BOTTOM LINE INCLUDE:

- **Lower Capital Investment**
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An Extru-Tech Single Screw Extrusion System provides flexibility and production efficiencies at substantially lower operating costs than competitive extrusion systems.

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