FOOD PROCESSING

SPECIAL REPORT

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Processing Plant-Based Proteins

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Alternative Proteins: The Problems and the Promise

Thoughtful ingredient blending and new processing techniques will keep the use of plant proteins growing.

By Food Processing

The push is on. A multitude of food industry stakeholders advocate increased consumption of plant-based foods. "Plant-based products are not only sought after by core vegan or vegetarian consumers, but by shoppers aspiring to have a healthier diet or following a flexitarian lifestyle," points out Mandy Bottomlee, director of content marketing at Good Foods Group, which makes mostly plant-based dips, salad dressings and juices (and they were Food Processing's 2020 R&D Team of the Year).

Fortunately, "Formulators of processed foods and beverages have an abundance of protein sources from which to choose," says B. Pam Ismail, professor in the Dept. of Food Science and Nutrition at University of Minnesota and director of the Plant Protein Innovation Center (PPIC). "Cost, supply reliability and safety are important factors. Additionally, much research is going into how to improve emerging plant proteins' key attributes of flavor, functionality and nutrition."

Consumers frequently compare taste and nutritional attributes of plant-based alternatives to traditional animal based-products, with animal sources often holding their own. Some three in 10 respondents to International Food Information Council's 2020 Food & Health Survey report never consuming plant-based meat and dairy alternatives. Thoughtful formulation efforts and advancing plant protein technologies can improve the competitiveness of these sources.

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MIMICKING MEAT

"Over the past decade, sales of plant-based 'meat' have skyrocketed, with U.S. grocery sales rising to $939 million," says Jacquelyn Schuh, product marketing director for alternative proteins & specialty ingredients at ADM. "Today, 44% of North American consumers self-identify as flexitarian, prioritizing a reduction in overall meat consumption and adding more plant-based foods to their diets."

Plant-based meat alternatives are often looked at as a new category. However, industrially produced plant-based analogues have been around for over half a century, especially at ADM.

"The original textured vegetable protein, or TVP, which we helped to formulate and is a trademark of ADM, was invented by William T. Atkinson in the 1950s and 1960s," says Schuh. Atkinson developed a process to "texturize" soy flour into a meat-like substance using

an extruder with mechanical shear and heat, combined with the injection of water.

"The original TVP was a fibrous, spongy material used as a standalone meat alternative product, as well as a nutritional extender in meat and poultry products to reduce costs and increase protein content."

Through the years, technological advances in processing and ingredients led ADM to expand its textured protein portfolio. Ingredients with more neutral flavor and light color profiles were developed to ensure that product developers could start with a blank slate when creating applications such as chicken, fish and seafood.

Other examples of ingredients designed for specific applications include ADM's recently introduced lines of textured pea proteins and textured and non-textured wheat proteins. Prolite MeatTex and Prolite MeatXT wheat proteins contribute meat-like texture for meat and seafood alternative products.

To meet specific label requirements and desired finished product attributes, formulators can move beyond use of whole components such as nuts, seeds, pulses and textured protein ingredients to add functional protein powders.

"Consumers often want a plant-based chicken-style patty to have the same appearance, bite and flavor as a traditional chicken," says Schuh. One tactic is to blend a high-quality textured soy protein concentrate with a soy protein isolate.

PERFORMING PROTEIN PROPERTIES

With decades of research and commercial development behind soy ingredients, they still dominate the plant protein marketplace due to their benefits as fortifiers and functional additives.

However, "Pea proteins have increasingly competed with soy in the past five years," says Ismail. Currently there is a lot of research into enhancing their production processes to expand the functionality of these ingredients.

Other market newcomers such as flours and proteins from other pulses (e.g., chickpeas, lentils, fava and mung beans) have similar environmental benefits and are being looked at for their nutrition and functionality.

Innova Market Insights data from late-2020 analyzed the top five ingredients used as alternative proteins (as a percent of 2019 global food and beverage launches tracked with alternative proteins). Wheat gluten was used in 44% of the new products; soy protein and soy protein isolate in 17% and 11% respectively; hydrolyzed vegetable protein and pea protein each claimed 8% of new launches.

"Research is ongoing into how to improve the functional properties of the many emerging plant-based alternative proteins," says Ismail. Although there are protein powders such as hemp, sunflower and others for consumer, foodservice and other users who simply wish to blend extra protein into a product, more research is required if used for functionality in industrial formulations, Ismail adds.

Research at PPIC also is looking into leaf sources of proteins

Through the years, technological advances in ingredients and processing have increased the plant-based protein portfolio.

(e.g., alfalfa as well as its seeds), nuts and certain grains, particularly oats, rice and corn (the last is more of a challenge). There also is much interest into how to use hemp seed as a source of protein; also oilseed crops beyond soy, such as sunflower, canola (or rapeseed), camelina and pennycress.

Much of Ismail's research focuses on enhancing protein functionality through optimized extraction processes and modification. During processing, conditions such as temperature, shear and pH changes can cause proteins to unfold (i.e., denature) and aggregate. Protein aggregates are not soluble and thus may have poor functionality in some applications.

Merit Functional Foods is an example of one company that has focused on manufacturing to produce differentiated protein ingredients. "Our process for making pea protein differs from most other protein extraction processes," says Co-CEO Ryan Bracken. Unique and useful ingredient functionalities have been developed by modifying the ratios of certain protein types or classes in the finished protein ingredient.

The company also concentrates and purifies its pea proteins using membrane technology. This technology has several advantages, notes Bracken. Not only is most of the protein's native functionality maintained, but off-flavors, compounds that cause dark coloration and even anti-nutritional factors are reduced or removed. "The resulting protein is light in color, low in pea flavor intensity and higher in digestibility and solubility. This translates to a creamy, dairy-like experience when using our Peazac 850 in ready-to-mix protein powders."

The company also relays that the ingredient's higher solubility across a wide pH range enables a creamier mouthfeel in various applications without added texturizing ingredients. The creation of great tasting plant-based protein alternatives becomes even more challenging when clean labels are also the goal.

ANOTHER CHALLENGE: KEEPING IT CLEAN

Plant-based foods striving to match the sensory attributes of animal-based products often have lengthy ingredient statements, which can counter clean label efforts. For example, the Impossible Burger has 21 ingredients and one of Beyond Meat's items has 17 ingredients listed on its ingredient label.

Processing might help with clean label efforts. High-pressure processing (HPP) can assist in reducing the number of ingredients by eliminating the need for certain binders for product stability and food preservatives used for food safety and shelf-life extension, says Errol Raghubeer, senior vice president of microbiology-HPP & biotechnology at Avure Technologies, a JBT business.

HPP is used by Good Foods Group, Hope Hummus, Sabra, Cedarlane Foods, The Skinny Butcher and others in the manufacture of plant-based dips, hummus, salad dressings, ready meals, etc., to maximize shelf life and to ensure product safety. HPP may possess other ingredient benefits as well by increasing the functionality of hydrocolloid materials.

Plant-based alternative products are booming. Their sensory and nutritional qualities are sure to increase in the coming years. ◻

The Mechanics of Plant-Based Food: Hosokawa Equipment Turns Legumes and Pulses Into Usable Protein

Plant-based food is undeniably the wave of the present, and probably the future, too. It pleases consumers who are concerned about the environment and those who seek a healthier diet, two giant trends that are affecting consumption patterns around the world.

Just one statistic sums it up: Demand for plant-based meat is expected to double from 2022 to 2027, reaching more than $35 billion, according to a 2021 report from Global Industry Analysts.

But most plant-based foods don't go straight from the farm to the table. It takes a detour through the manufacturing process, and that highlights the key role of equipment that can reliably turn sources of plant protein, such as pulses and legumes, into ingredients suitable for commercial food processors.

"The whole thrust of the plant-based food industry is deriving protein from plants," notes Frank Bernero, food applications manager at Hosokawa Micron Powder Systems. "The goal is to extract as much protein from the plant as possible, given the customer's parameters and manufacturing requirements."

Hosokawa makes equipment for food manufacturers that grinds pulses and legumes and separates the protein from the starch and other components. The grinding and separation are two distinct processing lines. This is true for large scale production as well as small lab scale evaluation. Because Hosokawa manufactures both types of equipment, clients can depend on smooth and efficient transitions from one stage of the process to the next.

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>
> — Frank Bernero, Hosokawa Micron Powder Systems

The first stage in the process is grinding the legumes or pulses. Hosokawa grinders are designed to create particles that match the customer's manufacturing requirements. For example, a food processor making a smoothie or other beverage may want a fine grind because it is more soluble and results in a smoother end product. On the other hand, a manufacturer of plant-based hamburgers may want a coarser grind that provides a more meat-like mouthfeel.

"The grinding step liberates the starch and the protein so they are separable," Bernero says. "If you looked at the grains under an electron microscope, you would see that the starch particles look like baked potatoes and the protein looks like little salt granules on the baked potatoes."

Once the peas or beans are ground, the resulting powder stream moves into the classification part of the system. Hosokawa pioneered air classification, a process

that separates the starch from the protein.

The air classifier uses one or more classifier wheels, which are cylinders with specific size slits in them. A downstream fan pulls the powder over the rotating cylinders. The smaller particles – the protein – slip through the slits in the wheels and fall into a container. The larger particles – the starch – don't fit in the slits, so they drop down into a different container. Voila! The protein is separated from the starch.

The classifier process is called "forced vortex" because of the constant flow of air. The process is not perfect – there is always some starch in the protein container and vice versa. But a well-tuned classifier maximizes the separation.

In low-capacity separators, one wheel is enough to handle the powder flow. But when clients need to classify large quantities – such as several tons of material per hour — they turn to Hosokawa separators with multiple classifier wheels. This technology was developed exclusively by Hosokawa and greatly increases the amount of flow that can be handled.

"The multiple-head classifier wheels use a series of smaller wheels to accurately handle large volumes," Bernero explains. "They are unique to our design."

Naturally, an important characteristic of a quality classifier is its ability to accurately separate the particles depending on size. For example, if the operator wants to separate particles that are 20 microns or smaller from particles that are larger than 20 microns, the preciseness by which it does that is an important characteristic. The term used for that is "cut."

"The preciseness of the cut is very important, and that's what the Hosokawa ATP Classifier provides," Bernero says. "It gives a sharp, distinctive separation of coarse going in one direction and fine going in the other."

The measurements most commonly used in protein fractionation – which is the technical term for isolating the protein from the plant source – are percentage yield (which refers to the percentage of available protein in a legume or pulse that is extracted) and percentage protein fraction (which refers to the concentration level, or purity, of the extracted protein). In general, the higher the yield, the lower the purity.

Bernero says the baseline measurements for protein extraction using the dry method – which is the method Hosokawa equipment uses and which means water is not added during the process – is about 30 percent yield at 55 percent concentration. "That's kind of middle-of-the-road, and we can adjust that to tweak for a higher protein concentration," he says.

"But that may influence the yield and bring it a bit lower," he continues. "It's a seesaw effect where you can influence one aspect or the other by changing the parameters. Obviously, you try to shoot for the maximum amount of protein given the conditions."

Competing systems that use a wet process can provide a higher concentration of the protein in the extract, Bernero says. But the trade-off is that the resulting product needs to be dried, which

One food processor may want a fine grind for a smoothie or other beverage; another may want a coarser grind for plant-based hamburgers.

requires extra equipment and energy. In fact, a 2021 study at the University of Goias in Brazil noted that "dry fractionation is a more sustainable method of protein extraction, as it uses few resources and preserves the native properties of proteins."

When a food processor purchases a protein fractionation system from Hosokawa, the company ensures the system meets the client's needs. They discuss the desired end product, the inputs, the required speed and quantity and other factors. They can even test the material the client proposes to feed into the system and use the information gleaned from that to correctly set the variables before the equipment is delivered.

At installation, technicians test all the components to make sure everything is working as planned, and they train the client on how to adjust parameters and control the equipment. If a Hosokawa system includes components from another manufacturer, technicians from that manufacturer join the process to make sure everything works smoothly together. The bottom line is that when a system is delivered, it works the way the client expects.

"Our technology and support teams collaborate to make sure our clients achieve what they want with our equipment," Bernero stresses.

Often, however, a client's needs change. Fortunately, the equipment can adapt. "Sometimes we'll get a call from a client and they'll need something totally different. Our equipment is flexible, nothing is set in stone," Bernero explains.

"We have clients, especially on the food side, who will tell us they're grinding one material but then they come back to us later and say they're grinding something else. That's not a problem – our equipment is designed to accommodate a wide range of applications."

This is especially important considering that even different variations of the same material can require different settings in the equipment. A yellow pea from North Dakota will differ from a yellow pea from Saskatchewan, Bernero says. One may have more protein or starch than the other, and consequently the settings that produce the best yield and concentration may differ. Conditions may even vary by time of year when the plant is harvested.

There are many adjustments to the equipment clients can make themselves, such as the flow of the air and the rate at which the material is delivered. Some other adjustments are made by Hosokawa technicians. In some cases, the client authorizes Hosokawa technicians to monitor and adjust equipment remotely. They can see the trending history of the equipment and determine if adjustments need to be made to ensure optimal performance.

Another characteristic of Hosokawa equipment is longevity. The company was founded nearly 100 years ago and some equipment manufactured more than a half century ago is still in service.

"I get calls from people looking for parts and when I ask them for serial numbers, they'll give me numbers for equipment that was made in the 1950s or 1960s," Bernero says. "That equipment is still out there running, and we still support it." □

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