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Bala Balasubramaniam, PhD, director of the High Pressure Food Processing Laboratory at Ohio State, and laboratory researchers investigate the food quality and nutritional quality benefits of preserving foods using high-pressure processing.

COOL UNDER PRESSURE

High-Pressure Food Processing May Offer Benefits Without Need for Heat

By Maura Keller

Open a newspaper or visit a news website and you're bound to find stories about food safety, food recalls, or other food-processing issues. The food industry is continually searching for food-processing techniques that result in great-tasting, safely prepared foods with a long shelf life. Enter high-pressure processing (HPP), or pascalization, a unique method of sterilizing and preserving foods that is making inroads in the industry.

At Its Core

According to Bala Balasubramaniam, PhD, an associate professor of food safety engineering at The Ohio State University, HPP is a novel food preservation technique used to inactivate harmful pathogens and vegetative spoilage microorganisms present in a food through the application of pressure rather than heat.

"HPP utilizes intense pressure [about 400 to 600 [megapascals] or 58,000 to 87,000 psi] at chilled or mild process temperatures (less than 45°C), allowing most foods to be preserved

with minimal effects on taste, texture, appearance, or nutritional value," Balasubramaniam says. "Pressure in combination with heat (90°C to 120°C) can also be used to inactivate bacterial spores and help process shelf-stable foods."

HPP is primarily used as a batch process. During the treatment, prepackaged food products are treated in a chamber surrounded by water or another pressure-transmitting fluid. "Semicontinuous systems are used for pumpable liquid foods where the product is compressed in bulk and subsequently packaged 'clean' or aseptically," Balasubramaniam says.

Avocado-based products, especially guacamole, represent the first wave of pressure-treated products commercialized in the United States. As Balasubramaniam explains, Fresherized Foods (formerly Avomex) began the first industrial production of guacamole in North America in 1997.

"As a versatile technology, pressure-treated meats, seafoods, fruits and vegetables, and juices are commercially available," Balasubramaniam says. "Hormel Foods, Kraft Foods, Perdue, Foster Farms, Motivait Seafoods, and Wellshire Farms are examples of food processors that have successfully utilized the technology for a variety of food products. To date, pressure pasteurization represents a \$2.5 billion segment [of commercial scale food production]—a relatively small but growing industry."

How It Works

As George Flick Jr, PhD, of the Virginia Tech High Pressure Processing Laboratory in the department of food science and technology, explains, on HPP equipment there is generally a large cylinder into which food products (usually prepackaged in vacuum pouches or similar acceptable packaging) are placed. "The cylinder is then sealed and filled with water," Flick says. "Once it is full, a pump forces in more water, which is what causes and controls the amount of pressure applied. The water acts as the pressure transfer medium, and since the food product is surrounded by the water on all sides, the product experiences equal pressure from all directions."

Once the desired pressure is reached, the HPP unit holds that pressure for a specified time and then releases it almost instantaneously at the end of the run. The cylinder is drained and opened and the product is removed.

"If the product to be pressurized is pumpable (like orange juice), the product is pumped into the cylinder, pressure is applied, and then the product is pumped out and into its packaging," Flick says. "[Another option] is the processing of foods such as oysters, clams, crabs, lobster, and similar products. These are processed without packaging (although oysters may have a band placed around them so the shell does not open and allow the meat to fall out) but in a basket that allows the product to be surrounded by water."

What HPP Provides

Jack Aronson, owner of Garden Fresh Gourmet, the largest all-natural salsa company in North America that uses HPP in its processing, believes the benefits of HPP are plentiful. “HPP allows companies to make all-natural products that have an extremely long shelf life and maintain the integrity of the product’s flavor,” Aronson says. “With HPP, there is no after-taste from preservatives or negative health effects of preservatives. The drawbacks mainly have to do with expense. To purchase and set up one HPP machine, it costs nearly \$3 million. Plus, once you have the machine, you need a 24-hour support team for maintenance. Every night there is a two-hour breakdown for maintenance—oiling valves and such. It’s expensive, but we think it’s completely worth it.”

Balasubramaniam says HPP “provides food processors an opportunity to preserve foods with a ‘cleaner’ ingredient label and it is the process of choice for applications where heat pasteurization would adversely affect product quality.”

Jon Trelfa, president of Trelfa Labs, Inc, which offers food safety consulting and training as well as analytical laboratory testing, says the No. 1 benefit is that HPP can effectively remove pathogenic bacteria without damaging or negatively affecting the food itself. “The product is not heated to the point of pasteurization, so the proteins in meat items or the textures and appearances do not change,” Trelfa says. “And there are no ill effects of HPP. Because the process uses no chemicals, it can be used on all-natural products and products with health claims without altering the claim.”

While HPP can also be used to alter the functional and sensory properties of various food components, especially proteins, it has very little effect on low molecular weight compounds such as flavor compounds, vitamins, and pigments.

Balasubramaniam says HPP’s “ability to ensure safety and significantly extend refrigerated shelf life has opened new market opportunities, particularly in the area of ‘natural’ preservative-free meat products.”

Pressure treatment is effective at inactivating pathogenic bacteria such as *E coli*, *Listeria*, *Salmonella*, and *Vibrio* as well as many yeasts, molds, and food spoilage bacteria. “Most viruses can be eliminated by pressure treatments designed for eliminating bacteria of concern,” Balasubramaniam says. “Bacterial spores can be difficult to inactivate using HPP and require higher pressures, process temperatures, and holding times as compared to vegetative cells. *Clostridium botulinum* strains have been identified as the most pressure temperature-resistant pathogenic spores.”

Trelfa agrees that the main drawback to HPP is that some organisms can survive the process. “HPP is not a silver bullet,” he says. “Our laboratory has tested occasional products that have been through an HPP process yet failed in the field prior to their stated shelf life. Results have indicated that

[some] hearty organisms such as coliforms, *Pseudomonas*, and *Clostridium* can survive the HPP process in some food types. The key is to start with the cleanest product possible and allow HPP to eliminate any potential lingering organisms, not to use HPP to clean a soiled product.”

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— Jack Aronson, owner of Garden Fresh Gourmet

Additionally, research has shown that HPP may not be effective on some plant materials (eg, onions). Also, since HPP equipment is costly, most companies outsource the process, which requires time to send the product to the HPP location and additional time to get it back. “Because of the cost and the extra handling involved, a lot of places aren’t interested in HPP,” Aronson says. “It does add 10 to 15 cents per pound of product. So for people [who] aren’t doing a premium product, this isn’t for them.”

What the Future Holds

At its core, HPP is a paradigm-shifting technology for the food industry that is on par with consumers’ interest in minimal food processing. “The process delivers a ‘clean’ ingredient statement, fresher flavor, and better nutrition,” Balasubramaniam says. “It is generally known that pressure treatment preserves the nutrient content of the foods, and this is a topic of current research interest.”

“The process does not degrade the product, yet it provides pasteurization,” Trelfa says. “It is a win-win. Many large firms use this technology to protect their brands and the trend, I believe, is moving upward.”

Flick advises dietitians, healthcare providers, and other foodservice personnel to remember that HPP foods should be utilized with consideration of the same concerns as food products processed by other methods. “These products have expiration dates just as non-HPP products do. And if the packaging is swollen or broken, you shouldn’t use it, no matter the method of processing,” he says. “However, it is possible that some of the HPP products will have a slightly different texture or other physical characteristics. So, as with any new food you incorporate, you need to try it to see if you find it acceptable. Some people may like it better and some may not.”

— Maura Keller is a Minneapolis-based writer and editor.