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THE OHIO STATE UNIVERSITY EXTENSION

Extension FactSheet

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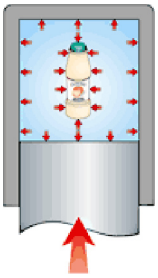
High Pressure Processing

Fact Sheet for Food Processors

Raghupathy Ramaswamy, Graduate Research Associate, Department of Food Science and Technology
V.M. (Bala) Balasubramaniam Ph.D., Assistant Professor, Food Safety Engineering, Department of Food Science and Technology
Gönül Kaletunç Ph.D., Assistant Professor, Food Safety Engineering, Department of Food, Agricultural and Biological Engineering

1. Why high pressure processing?

High Pressure Processing (HPP) is a method of food processing where food is subjected to elevated pressures (up to 87,000 pounds per square inch or approximately 6,000 atmospheres), with or without the addition of heat, to achieve microbial inactivation or to alter the food attributes in order to achieve consumer-desired qualities. Pressure inactivates most vegetative bacteria at pressures above 60,000 pounds per square inch. HPP retains food quality, maintains natural freshness, and extends microbiological shelf life. The process is also known as high hydrostatic pressure processing (HHP) and ultra high-pressure processing (UHP).



2. How does this technology benefit consumers?

High pressure processing causes minimal changes in the 'fresh' characteristics of foods by eliminating thermal degradation. Compared to thermal processing, HPP results in foods with fresher taste, and better appearance, texture and nutrition. High pressure processing can be conducted at ambient or refrigerated temperatures, thereby eliminating thermally induced cooked off-flavors. The technology is especially beneficial for heat-sensitive products.

3. How does HPP work?

Most processed foods today are heat treated to kill bacteria, which often diminishes product quality. High pressure processing provides an alternative means of killing bacteria that can cause spoilage or food-borne disease without a loss of sensory quality or nutrients.

In a typical HPP process, the product is packaged in a flexible container (usually a pouch or plastic bottle) and is loaded into a high pressure chamber filled with a pressure-transmitting (hydraulic) fluid. The hydraulic fluid (normally water) in the chamber is pressurized with a pump, and this pressure is transmitted through the package into the food itself. Pressure is applied for a specific time, usually 3 to 5 minutes. The processed product is then removed and stored/distributed in the conventional manner. Because the pressure is transmitted uniformly (in all directions simultaneously), food retains its shape, even at extreme pressures. And because no heat is needed, the sensory characteristics of the food are retained without compromising microbial safety.

4. Can HPP be used for processing all foods?

Like any other processing method, HPP cannot be universally applied to all types of foods. HPP can be used to process both liquid and solid foods. Foods with a high acid content are particularly good candidates for HPP technology. At the moment, HPP is being used in the United States, Europe, and Japan on a select variety of high-value foods either to extend shelf life or to improve food safety. Some products that are commercially produced using HPP are cooked ready-to-eat meats, avocado products (guacamole), tomato salsa, applesauce, orange juice, and oysters.

HPP cannot yet be used to make shelf-stable versions of low-acid products such as vegetables, milk, or soups because of the inability of this process to destroy spores without added heat. However, it can be used to extend the refrigerated shelf life of these products and to eliminate the risk of various food-borne pathogens such as *Escherichia coli*, *Salmonella* and *Listeria*. Another limitation is that the food must contain water and not have internal air pockets. Food materials containing entrapped air such as strawberries or marshmallows would be crushed under high pressure treatment, and dry solids do not have sufficient moisture to make HPP effective for microbial destruction.

5. Will the process damage the food product?

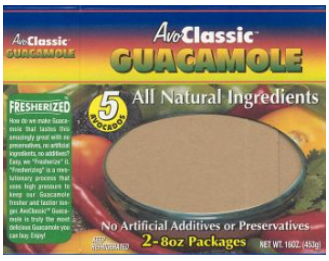
During HPP, pressure is uniformly applied around and throughout the food product. For example, a grape placed between fingers can be easily squeezed and broken; this is because the pressure is not applied evenly from all sides simultaneously. On the other hand, if the same grape is squeezed from all sides simultaneously, it will not be crushed. This can be demonstrated by placing a grape inside a soda bottle filled with water. By squeezing the bottle, you pressurize the water inside as well as the grape. Yet the grape is not damaged, no matter how hard you squeeze. In the same way, foods processed by high pressure will not be damaged by the applied pressure.

6. What is the shelf life of an HPP processed product?

In general, HPP can provide shelf lives similar to thermal pasteurization. Pressure pasteurization kills vegetative bacteria and, unless the product is acidic, it requires refrigerated storage. For foods where thermal pasteurization is not an option (due to flavor, texture or color changes) HPP can extend the shelf life by two to three fold over a non-pasteurized counterpart, and improve food safety. As commercial products are developed, shelf life can be established based on microbiological and sensory testing.

7. Are HPP products commercially available?

Yes. High pressure processed products are commercially available in the United States, European, and Japanese retail markets. Examples of high-pressure processed products commercially available in the United States include fruit smoothies, guacamole, ready meals with meat and vegetables, oysters, ham,



chicken strips, fruit juices, and salsa. Low acid, shelf-stable products such as soups are not commercially available yet because of the limitations in killing spores with HPP. This is a topic of current research.

8. What functional properties does HPP impart to food products?

It is generally known that high pressure has very little effect on low molecular weight compounds such as flavor compounds, vitamins, and pigments compared to thermal processes. Accordingly, the quality of HPP pasteurized food is very similar to that of fresh food products and the quality degradation is influenced more by subsequent storage and distribution rather than the pressure treatment. Pressure also provides a unique opportunity to create and control novel food textures in protein-based or starch-based foods. In some cases, pressure can be used to form protein gels and increase viscosity without using heat.

9. How are HPP processed foods stored?

HPP products currently marketed worldwide are primarily distributed refrigerated. In some cases this is necessary for safety (to prevent the growth of spores in low-acid foods). For acid foods, refrigeration is not a necessity for microbial stability, but is used to preserve flavor quality for extended periods of time.

10. Is commercial scale equipment available?

Yes. In the United States, Avure Technologies (Kent, WA) sells commercial size (215-liter capacity) batch type HPP equipment. A 215-liter batch system has the capacity to produce about 10 million pounds of food per year.

The company also makes semi-continuous systems for the processing of clear liquids such as juices. While commercial pressure vessels have the pressure limit of 100,000 pounds per square inch, research machines can go up to 150,000 pounds per square inch. Pilot/lab scale HPP research systems are made by several vendors in the United States (see the OSU HPP website for more details).

11. Is HPP equipment safe to operate?

High pressure equipment design is a mature technology and has its origin in the chemical processing industry. Most high-pressure vessels are manufactured under guidelines established by the American Society of Mechanical Engineers (ASME) boiler and pressure vessel codes. Processors should also ensure that the vessels are manufactured, installed, tested, and operated according to relevant state regulations. With a little training, food plant personnel can learn to safely operate the equipment.

12. How economical is HPP processing?

A commercial scale, high-pressure vessel costs between $500,000 to $2.5 million dollars depending upon equipment capacity and extent of automation. As a new processing technology

with a limited market, pressure-processed products may cost 3 to 10 cents per pound more to produce than thermally processed products. With two 215-liter HPP units operating under typical food processing conditions, a throughput of approximately 20 million pounds per year is achievable. High throughput is accomplished by using multiple pressure vessels. Factory production rates beyond 40 million pounds per year are now in operation. As demand for HPP equipment grows, capital cost and operating cost will continue to decrease. Consumers benefit from the increased shelf-life, quality, and availability of value-added products and new types of foods that are impossible to make using thermal processing methods.

13. What regulatory approval is required for commercializing an HPP processed product?

HPP does not present any unique issues for food processors concerning regulatory matters or labeling. The requirements are similar to traditional thermal pasteurization or sterilization in the United States, where the Food and Drug Administration (FDA) and the Department of Agriculture (USDA) are responsible for evaluating and monitoring the safety of HPP processed foods.

14. Are facilities available for product development before venturing into HPP processing?

There are a number of research facilities throughout the United States and Europe where food processors can evaluate HPP technology. In Ohio, facilities are available at The Ohio State University in the Department of Food Science and Technology and the Department of Food, Agricultural and Biological Engineering. Food processors are invited to take advantage of the expertise of OSU faculty members and facilities to conduct confidential product evaluations for food safety, quality, and shelf life, and to obtain guidance on product development. The resources at OSU can be accessed for a nominal fee.

For additional information, contact:

Department of Food Science & Technology (614/ 292 1732),
Department of Food, Agricultural and Biological Engineering (614-292-0419)

College of Food, Agricultural and Environmental Sciences,
The Ohio State University, Columbus, OH 43210-1007

Visit OSU HPP technology web page:

http://grad.fst.ohio-state.edu/hpp/

"Reference to commercial product or trade names is made with the understanding that no endorsement or discrimination by The Ohio State University is implied. Support of USDA-CSREES National Integrated Food Safety Grant No. 2003-51110-02093 is gratefully acknowledged."