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How is High Pressure Processing Used to Process Food?

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Background

High pressure processing (HPP) is a technology in which foods are exposed to high pressure inside a chamber. The high pressure kills microorganisms and breaks down enzymes (molecules that speed up the rate of chemical reactions in food, like browning) without the use of extreme temperatures (Fellows 2009). A variety of products like fruit juices, guacamole, and even oysters can be processed using HPP (figure 1).

Figure 1. A package of a guacamole product that has been processed using HPP to extend its shelf life. (Photo courtesy of Nicole Arnold, Virginia Tech.)

How It Works

HPP exposes food to very high pressure. Dry foods cannot be used for HPP; foods must contain water because water is needed for the pressure to destroy pathogens (Fellows 2009). Food or food packaging that incorporates entrapped air is not appropriate to use for HPP; the high pressure will crush and dramatically change the shape of the food and packaging (Fellows 2009) (figure 2).

Figure 2. Products that contain a high volume of air, such as plastic foam cups, shrink after being exposed to HPP. (Photo courtesy of Nicole Arnold, Virginia Tech.)

Technology

Pressures applied inside the HPP chamber can range from 100 to 800 MPa (megapascal pressure unit), or between 14,500 to 116,000 pounds per square inch (psi). As a comparison, 400 MPa of pressure is equal to balancing two adult elephants on top of a dime; 800 MPa is equal to the pressure of stacking four elephants on top of a dime. Depending on the food product, processing times can be as short as a millisecond pulse of pressure or as long as 20 minutes (Fellows 2009).

HPP uses a form of pressure called isostatic pressure. This means that pressure is applied instantly and uniformly across the entire product; it can be applied continuously or pulsed through the HPP system in three different ways: batch processing, continuous processing, or semi-continuous processing (Farkas and Hoover 2000).

Batch processing is used most frequently to treat solid foods already in their packages. In batch processing, the product is placed in a vessel that is filled with water. Water pressure is held for the desired amount of time and then quickly released to depressurize the chamber.

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Continuous and semi-continuous processing works best for liquid foods (e.g., fruit juices, olive oil, milk). The fluid product is held in a tank. At the start of the HPP process, liquid flows into a chamber; once inside the chamber, the liquid product is exposed to high pressure. The pressurized product then travels through a tank (called the surge tank) that either directly fills the product into its final packaging or flows the product into another tank until it can be packaged later (Farkas and Hoover 2000).

Figure 3. This is a pilot-scale high pressure processor that performs batch processing. (Photo courtesy of Brett Driver, Virginia Tech, Department of Food Science and Technology.)

Efficacy

HPP is effective in killing bacteria, yeasts, molds, and some viruses. The process can also be combined with other processing methods to be even more effective (Farkas and Hoover 2000). Pathogens like Listeria monocytogenes, Staphylococcus aureus, E. coli, and Salmonella Typhimurium can be reduced (NSW 2016). Components of the food (i.e., fat content, pH, and moisture) can affect the number of pathogens that are destroyed.

Benefits

HPP is generally a nonthermal (minimal to no heat) process. It is favored because it can process food while still preserving the food's sensory characteristics such as flavor, shape, and texture, and its nutritional value (Fellows 2009). It can also be used to increase flavor penetration using sugar and spices, to quickly tenderize meat products, and to shell/shuck fresh oysters while maintaining their desired raw flavor (Fellows 2009). Another benefit with batch processing is that the post-processing contamination of the product is significantly reduced since the food is processed inside the package (Farkas and Hoover 2000).

Current Usage

HPP is an approved process in the United States. While it can be used on a wide range of food products, each specific food/pressure combination needs to be validated and supported by scientific evidence as safe in order to be approved. Although HPP processing times are much shorter than traditional processing technologies, the cost of purchasing and operating HPP machinery can be prohibitive. Therefore, HPP is currently only used at an industrial level (Fellows 2009). Small processors will often contract with land-grant universities or larger companies to use an HPP system. Some common foods currently in grocery stores that are processed with HPP include hummus, guacamole, soups, cold-pressed juices, and salad dressings.

References

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