# High Pressure Processing in Dairy Industry

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High-pressure processing (HPP) is a "non thermal" food preservation technique that inactivates harmful pathogens and vegetative spoilage microorganisms by using pressure rather than heat to effect pasteurization. HPP utilizes intense pressure (about 400–600 MPa) at mild process temperatures (<45°C), allowing most foods to be preserved with minimal effects on taste, texture, appearance, or nutritional value. Also known by the name of Pascalization, bridgmanization, hydrostatic-pressure processing (HHP) or ultra-high-pressure processing (UHP).

Regardless of its nomenclature, the technology has been cited as one of the best innovations in food processing in 50 years (Dunne, 2005). It 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. Pressure treatments of 400 MPa for 15 min or 500 MPa for 3 min at room temperature achieves microbiological reductions similar to thermal pasteurization but it is not used commercially because long pressure processing times are not financially viable. HPP treatments (586 MPa for 3 and 5 min) at moderate temperature (55°C) extend the refrigerated shelf life of milk to over 45 days while retaining milk volatile profiles similar to those observed after conventional HTST treatments. Finally, ultra high temperature (UHT) processing (135–150°C for 3–5 s) yields milk that is stable at room temperature for 6 months; however, this process induces strong 'cooked' off-flavour notes thus limiting its consumer acceptance in important markets.

The most attractive feature, which made the process worldwide acceptable, is its uniform processing ability, independent of mass and time. The HHP can be used to process both liquid and solid (water-containing) foods and adds advantages to the foods such as (i) Kills bacteria in the raw food, (ii) Extends shelf-life, (iii) Ponders additive free and fresh food, (iv) Manipulates the texture and (v) Enhances desired attributes (digestibility). A newer concept of Pressure-Assisted Thermal Processing Technology (PATP) is coming into role giving a synergistic effect with combination of high pressure and high temperature

The operating principles behind this technology are as follows:

- *Le Chatelier's principle*: Any phenomenon in equilibrium chemical reaction, phase transition and/or change in molecular configuration is accompanied by decrease in volume, which can be enhanced by pressure.
- *Isostatic principle*: The transmittance of pressure is uniform and instantaneous (independent of size and geometry of food).

**General Description of HP Equipment**

For Food Industry The main components of an HP system are a pressure vessel, a pressure generation system, a temperature control device and a material handling system. Most pressure vessels are made from a high tensile steel alloy 'monoblocs' (forged

from a single piece of material), which can withstand pressure of 400-600 MPa. For high pressures, prestressed multilayer or wire-wound vessels are used. In operation, after all air has been removed, a pressure transmitting medium (either water or oil) is pumped from a reservoir into the pressure vessel using a pressure intensifier until the desired pressure is reached. Temperature control in commercial operations can be achieved by pumping a heating/cooling medium through a jacket that surrounds the pressure vessel. This is satisfactory in most applications as a constant temperature is required but if it is necessary to change the temperature regularly, an internal heat exchanger is fitted. There are two methods of processing foods in high pressure vessels: in-container processing and bulk processing. There are two main types of High pressure equipments:

1. Batch type: A batch press can be used for any kinds of food in flexible packages, such as pouches, cups, or bulk bags. With the food already packed in the final consumer package at the processing stage, the risk of contamination is eliminated. The food packaged, are placed in the pressure vessel where they are isostatically compressed
2. Continuous type: Continuous systems can be used for pumpable food. The system is installed with other equipment, and in the end the liquid food reaches an ascetic or clean filler. Thus, any kind of consumer package can be used. Top of-the-line, high quality juice may be perceived as more valuable if sold in glass bottles, rather than PET or other plastic that would require for batch cycling.

The volume in a pressure vessel for continuous use is better utilized that in a batch press, where there is dead space between the food packages. Thus the output volume is large despite the fairly small dimensions of the vessels used.

**Advantages of HPP**

- Retention of flavour and texture of the product
- Increase in Microbiological safety and shelf-life
- Low energy consumption
- Minimal heat input
- Minimal effluent and losses
- Uniform isostatic pressure & adiabatic temperature distribution
- Combination with heat gives better effects

**Application of HPP in Dairy Industry**

Milk treated at pressures of up to 500 MPa for few minutes has been shown to have a shelf-life at least equivalent to HTST pasteurized milk. Most vegetative cells, including non-spore forming thermodurics, can be eliminated. HHP treatment (200 MPa, 10 min) after acidification (rise of acidity after acidification) in yogurt, increases the water binding capacity of whey proteins. The cheese yield is not influenced when milk treated at pressure ≤ 250 MPa, but at 600-800 MPa, it gets increased by up to 25% with increase in moisture content in curd and decrease in protein content in whey.

Cheese Ripening can be accelerated by using the High-Pressure treatment, which avoids the usage of elevated temperatures, addition of cheese slurries or exogenous enzymes or by the use of adjunct starters. Cheddar cheese, when exposed to HP from 5 to 300 MPa for 3 days at 25°C, shows free amino acid levels of 26.5 mg/g at 50 MPa compared to 21.3 mg/g in the 6-month-old cheese (which had not been HP treated). The taste of both the cheese were described as ''excellent''. This shows a considerable

reduction in the ripening times of the cheese, attained through the application of HPP.

**Conclusion**

The HPP is a 'novel' non-thermal technology has the potential for use as an alternative to thermal processing. Several researches have been done on HP treatment on milk and milk products. These have provided a detailed understanding about the complex changes that take place in milk under high pressure like the dissociation of caseins micelles from the colloidal to the soluble phase, influence turbidity of milk etc. However, it cannot be denied that the dairy industry has been comparatively slow to adopt HP processing, as compared to product meat and sea-foods, jams, juices.

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