

High Pressure Processing (HPP): The simple way to healthy, long-life fruit juices

| Cold Pasteurization Process | High Pressure Processing (HPP) | Fruit Juices | Microorganisms | Smoothies |

Consumers increasingly seek healthy food choices based on fresh, natural, additive-free products. But most fruit juices today are thermally pasteurized, which leads to a significant loss of vitamins and nutrients. Taste and texture also suffer. High Pressure Processing (HPP) from thyssenkrupp is a safe, clean and eco-friendly process that extends the shelf life of fruit juices and purees up to ten times without the use of heat or additives and without compromising quality and freshness (see Fig. 2).



Fig. 1: High Pressure Processing (HPP): The simple way to healthy, long-life fruit juices
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Safe, clean and simple: Processing after packaging

In the HPP process, fruit juice is treated in its final packaging (tub, pouch, modified atmosphere packaging, etc.), i.e. after sealing. This means there is no risk of recontamination; aseptic filling is not required. The packaging merely has to be flexible enough to withstand compression of approx. 16 %. The packaging material must also be capable of interacting with water, which means

plastics are particularly suitable. For bottles PET materials are most commonly used, but LDPE and HDPE products are also possible. For solids, skin packaging, trays with flexible sealing films, and plastic bags can also be used.

Gentle process for long-life juices and smoothies

The HPP process caters directly to the trend towards healthy, high-quality foods. Compared with conventional thermal preservation techniques it processes food very gently – with pressure, but without heat.

How it works: After packaging, the food products are conveyed into a high-pressure vessel which is then filled with water. Intensifiers increase the pressure in the vessel to 6,000 bar. As the product is surrounded by water, the pressure is applied evenly from all sides and no shear forces are created. The product is treated gently and homogeneously. It is held under full pressure for a specific time to denature the pathogens. The system is then decompressed at a controlled rate and the product conveyed back out of the high-pressure vessel. It is then dried in a compressed-air dryer, if necessary labeled, and made available for sale.

The headspace (see Fig. 3) or gas filling in the packaging is not a factor. From a pressure of approx. 100 bar the gas dissolves almost completely and does not influence the rest of the process. During decompression the gas is released again from the product and the packaging; the packaging remains intact. Even a PET bottle with 50 % headspace is not damaged by HPP processing.

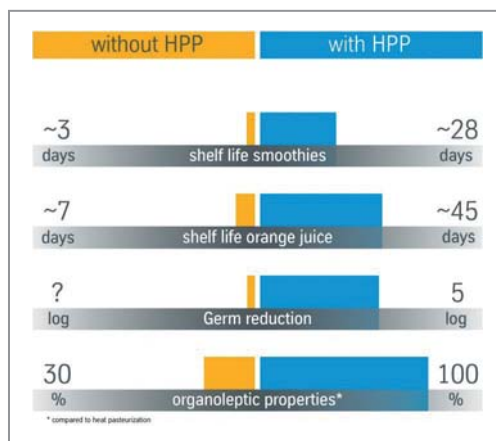


Fig. 2: Advantages of HPP over conventional pasteurization (figures may vary depending on product)

6,000 bar: No chance for fungi and pathogens

In the high-pressure vessel the product is subjected to a pressure of 6,000 bar. That is roughly equivalent to the weight of three jumbo jets acting on an area the size of a smartphone. Under these enormous forces the molecules are pressed closer together. This mainly affects long-chain proteins; covalent bonds are resistant to these pressures. The result is that the membrane permeability of

vegetative microorganisms is affected so they are denatured. On the other hand short-chain proteins are virtually unaffected, so flavors and vitamins are preserved virtually in their original condition.

By modifying process parameters such as pressure, holding time, and temperature, it is possible to control which types of microorganism are reduced. Depending on product properties, a four to five log reduction is possible. High-pressure processing is most effective with yeasts and molds, followed by parasites, viruses and vegetative bacteria (see Fig. 4). HPP is a cold pasteurization process not a sterilization technique because the microorganisms are not fully denatured. Spores are also resistant to the standard HPP process.

HPP – an established and safe process

The HPP process has been around for some time: The first experiments were carried out with milk in England in 1899. The first commercial use was in 1990 in Japan, where fruit jams were HPP treated to extend their shelf life. In the mid-1990s HPP orange juice started to appear on supermarket shelves in France.

The process has been meeting with increasing interest from the fruit and meat industries since the start of the millennium. Today around 50 % of the installed capacity is in North America (Canada, USA, Mexico), 25 % in Europe, and 25 % in the rest of the world. Globally around 400 HPP production units have been installed with vessel volumes of 35 l to more than 500 l. There is an increasing trend towards fresh, untreated, organic and above all safe products. Each year the number of HPP-treated goods in our supermarkets increases by 15 %. These include meat products, fruits and fruit juices, ready meals, seafood and dairy products.

HPP-treated products were subject to the Novel Food Regulation only until 2015. They now no longer have to be explicitly labeled.

Gentle to the product and the environment

As well as extending the shelf life of food products in a non-thermal process performed after packaging, the HPP process offers further advantages. To operate the equipment, only electricity and potable water are needed. Since the water can be reused, no effluent or waste is



Fig. 3: The volume of air in the packaging does not affect the product in the HPP process.

produced. The intensifier uses around 15 kWh electricity per cycle. That's roughly the amount of energy needed to heat the same volume of water by 10 °C. HPP is a purely physical process. No additives or chemicals are needed.

As the food is pre-packed, different products can be treated at the same time, e.g. fruit juice and fruit puree in the same cycle, offering operators increased flexibility. The pressure acts evenly throughout the food – unlike thermal treatment which acts from the outside in. The result is a gently processed, safe product.

HPP serves the growing market for fresh, natural products

The HPP process is ideally suited to the growing market for fresh, natural fruit juices and fruit products that are preserved without additives and with no loss of flavor or nutrients. Different types of treatment can be carried out. Product modifications are also possible. For example enzymes can be inactivated to prevent the discoloration of fruit products. Avocado dips are a good example: On exposure to air, the pulp of this “superfood” quickly turns brown. HPP ensures the dip stays not just fresh but also appetizing in appearance. The same is true for juices and fruit preparations: They retain their “freshly made” taste, appearance and texture.

The HPP process is not yet fully suitable for the global mass market because it operates with smaller capacities than thermal processing. Also the product has to be kept refrigerated after treatment.

Direct processing or processing in bulk bags also possible

Processing food in its final packaging is a batch process, eliminating the need for aseptic repackaging. Pumpable, low-viscosity products or pre-products can also be processed before they are packaged. One method of doing this is to convey the product directly through the pump intensifiers so that the pressure is increased not through water but through the product itself. With this technique however some of the food product is heated during decompression and has to be scrapped. In addition the equipment has to meet special standards of hygiene.

A further option involves processing the product in a large bulk bag that takes up the entire volume of the HPP machine. After processing, the bag can either be emptied or placed directly in storage. This permits extremely high fill levels. In both cases an additional aseptic packaging process is necessary.

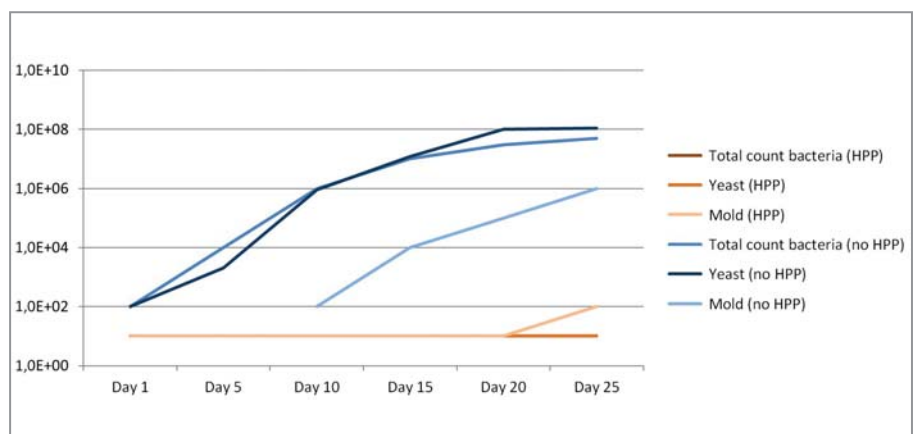


Fig. 4: Denaturation of yeasts and molds in the high-pressure processing of apple juice.

Operation and integration in production processes

HPP units from thyssenkrupp operate with just potable water, electricity, control air, and employees for loading and unloading the products. The process can also be automated. For this the belt conveyors leading to and from the system are connected to loading and unloading stations. These use either pick-and-place systems or special loading and unloading mechanisms. As a rule these systems are designed for a specific packaging form and have to be modified in the event of a change of product. A cost-benefit analysis should therefore be carried out to assess the benefits compared with manual loading. In addition the machines and their components are extremely robust and durable. They are manufactured using autofrettage, heat-shrink and wire winding technologies among others. The maintenance-friendly design of the equipment and durability of the components reduce downtimes to a minimum (see Fig. 5).

Depending on the size of the unit (vessel volume), utilization (shift operation), processing time (recipes) and fill level (product per cycle), the cost of HPP treatment



Fig 6: Toll processing: Fresh for less.

ranges from €0.1 to €0.5 per liter. While that is higher than the cost of conventional thermal processing, HPP enables producers to manufacture and supply natural goods that meet high quality and safety standards.



Fig. 5: High availability and efficiency: HPP machines from thyssenkrupp offer the advantages of maintenance-friendly design and long-lasting components.

Fresh for less: Toll processing

Smaller production sites and startups often have to operate on a tight budget. Toll processing allows them to use the advantages of high-pressure pasteurization for a small fee without having to invest in their own systems. They send us their product, we process it. It's as simple as that. Alongside a toll processing plant in Hagen (North Rhine-Westphalia, Germany), thyssenkrupp also has facilities in tolling centers around the world.

High-pressure pasteurization – one process solves multiple tasks

HPP offers producers and consumers numerous advantages over conventional pasteurization methods: Increased freshness, safety, and a truly high-quality product. Many different applications are already on the market. Food manufacturers profit from a safe, clean and gentle process which is also suitable for organic products and the corresponding EU organic certification. HPP can also be used for further applications, e.g. for product modifications and in the cosmetics and pharmaceuticals industries.



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