DRESSINGS, SAUCES AND SANDWICH FILLINGS

INTRODUCTION

High Pressure Processing (HPP) is a non-thermal food processing technology that allows increasing shelf-life and safety of sauces, dressings and sandwich fillings, while preserving the nutrients, fresh taste and appearance. On this sector of food products, the pressure range used is between 500 MPa (72,519 psi) and 600 MPa (87,000 psi) over few minutes, under refrigerated temperatures.

Regarding to a physico-chemical effect on food, the HPP technology is softer than a thermal treatment: it does not break or create covalent bonds, and does not create new compounds by molecule degradation, such as in a conventional thermal process. However, HPP is able to break, or create, weak bonds (hydrophobic and electrostatic interactions), only present on macromolecules such as proteins and polysaccharides (Cheftel, 1992). It allows for microorganism inactivation without modifying the food nutritional quality and without significantly altering enzymatic activities. To minimize the residual microorganism growth, the enzymatic reactions and changes in sensory attributes, these products must be stored at chilled temperature.

There are many reasons which make the HPP technology beneficial:

- Safer food products with a longer shelf-life are created thanks to the inactivation of vegetative microorganisms (bacteria, yeasts and molds).
- Reduction of preservatives or preservative-free dressings, sauces and sandwich fillings.
- Suitable for “clean label” and organic food products.
- Sensorial quality remain intact.

FOOD SAFETY AND MICROBIAL SHELF-LIFE

Consumers have a keen interest in preservatives-free food products. HPP technology is an effective method to reduce the microbiota without adversely affecting the sensory attributes and decreases or eliminate the dependence on chemical preservatives (Waite et al., 2009).

Shelf- life increase

Sauces, dressings and sandwich fillings can have a short shelf-life due to growth of lactic acid bacteria, yeasts, molds and other spoilage microorganisms. Shelf-life extension is due to inactivation of those spoilage microorganisms by pressure.

Ranch dressing

Ranch dressing, a salad dressing made of buttermilk, salt, garlic, onion, herbs and spices, has been processed by high pressure processing. This dressing (pH 4.4; aw 0.975) was processed at 600 MPa (87,000 psi) for 5 min, reaching immediate inactivation of native lactic acid bacteria and other known spoilage microorganism below detection limit (1 log cfu/g), reaching around 5 to 6 log-inactivation level (Waite et al., 2009)(**Figure 1**).

Lower pressures (400 MPa / 58,000 psi, 5 min) seem to be effective for controlling the most of spoilage microorganisms; however, there are some bacteria such as *Pediococcus acidilactici*, which requires higher pressure levels for significant inactivation.

HPP Processing (600 MPa / 87,000 psi, 5 min) produced a microbiologically stable dressing during 16 weeks stored at 4 ºC (39ºF) as well as 26 ºC (79 ºF) (Waite et al., 2009). HPP technology would allow producing a stable Ranch dressing even if the cold chain, a temperature-controlled supply chain, is broken. On the contrary, if this dressing is not HPP-processed, its shelf-life at 26 ºC (79 ºF) would be only 4 weeks (**Figure 2**).

Challenge tests

Dressings, sauces and sandwich fillings have been related to be possible vehicles of some foodborne outbreaks, mainly *Salmonella* and enteric viruses (EFSA, 2011; Kendall et al., 2013). HPP would provide a solution to achieve a 5-log reduction for pertinent pathogens of concern.

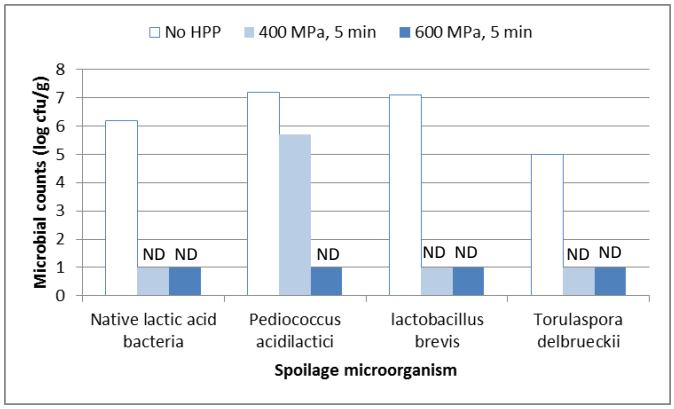

Figure 1. Effect of HPP on native and inoculated spoilage microorganisms in Ranch dressing (ND: not detected) (Waite et al., 2009).

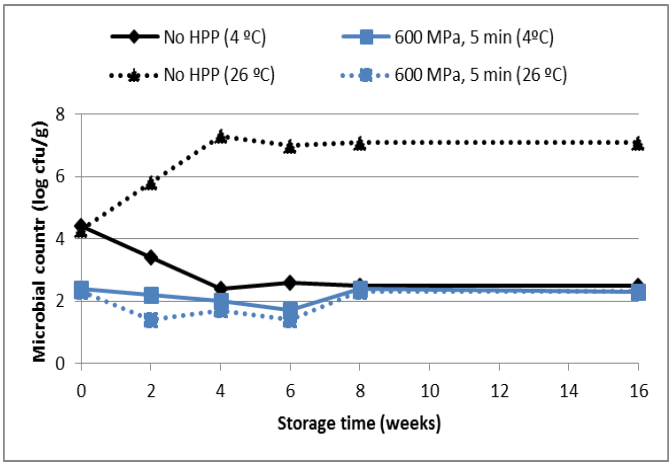

Figure 2. Evolution of total viable counts in Ranch dressing processed at 600 MPa for 5 min during storage at 4 ºC and 26 ºC during 16 weeks (Waite et al., 2009)

Peanut sauce

Inactivation of *Salmonella* spp. on peanut sauce (around pH 6, aw 0.99) by HPP was studied (Stiles, 2010). Peanut sauce and analogous products such as peanut butter has been linked with outbreaks of salmonellosis and product recalls across United States (CDC, 2009).

According to the authors, HPP was able to reach 5-log inactivation of a five strains cocktail of *Salmonella* spp. at pressure levels of 500 MPa (72,520 psi) and above during 5 min (**Figure 3**).

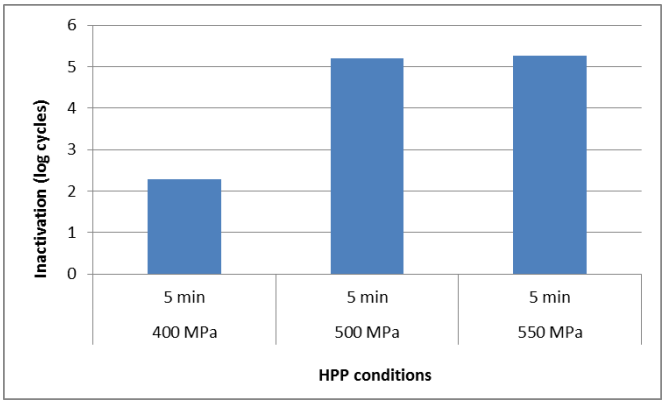

Figure 3. Inactivation of a cocktail of five strains of *Salmonella* spp. in peanut sauce processed at different pressure levels for 5 min (Stiles, 2010).

Mayonnaise-based fillings

Enteric viruses are the main biological agent causing food-related outbreaks in Europe in recent years (EFSA, 2011). Seafood and related food products such as seafood salads and sandwich fillings are one of the main vehicles for enteric viruses.

Feline calicivirus (FCV), a surrogate of noroviruses, and Hepatitis A virus (HAV) inoculated in seafood salad-based on mayonnaise were pressurized (Hirneisen *et al.,* 2012). FCV-inoculated samples were processed at 200 MPa (29,010 psi) during 2 min, while HAV-inoculated samples, at 400 MPa (58,015 psi) during 2 min at 5 ºC (41 ºF) (**Figure 4**).

HPP is a suitable technology for controlling FCV in mayonnaise-based products, reaching between 2 to 5-log inactivation levels at low pressure levels. The authors found HAV was more resistant to pressure than FCV. Inactivation levels of HAV were between 1.5 to 3 log cycles, depending on the type of seafood salad.

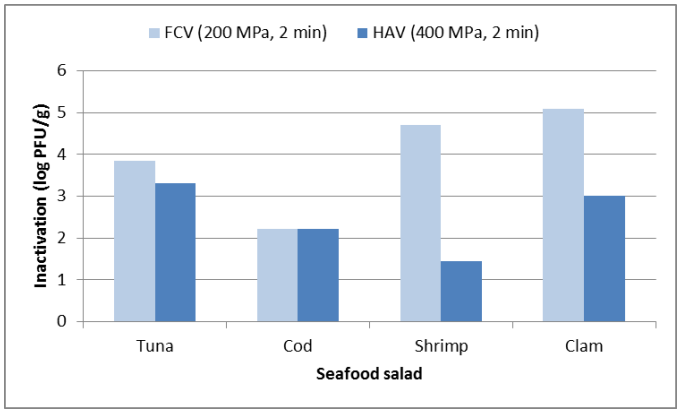

Figure 4. Inactivation of Feline Calicivirus (FCV) and Hepatitis A virus (HAV) by HPP (200 MPa, 2 min for FCV; 400 MPa, 2 min for HAV) in different mayonnaise-based seafood salads (Hirneisen et al., 2012).

Higher pressure levels, around 600 MPa (87,000 psi) and longer holding times, conventionally used in HPP pasteurization, could be used as HPP conditions for achieving higher inactivation levels of enteric viruses in mayonnaise-based products.

Influence of processing parameters and product characteristics

Microbial inactivation levels depend on the pressure and holding time as well factors related to food product such as water activity (a_w) or pH.

The lower water activity (a_w) the lower effectiveness high pressure is (Goh *et al.*, 2007); therefore, the technology is very effective on dressings, sauces and sandwich fillings. These products have a_w values between 0.95 to 0.99. Generally, HPP technology is effective on products with a_w values higher than 0.90.

The pH of a product is also a key factor to consider, working in synergy with HPP: the lower pH a product has, the more effective microbial inactivation by HPP is reached. HPP does not inactivate bacterial spores (but mold spores are inactivated). Products with a pH higher than 4.6 are at risk for spore germination and therefore they must be kept refrigerated throughout the shelf-life of the product. We recommend acidifying HPP sauces, dressings and fillings below pH 4.6 whenever possible to prevent spore germination.

Survival levels of microorganisms in oil-water emulsions made of egg yolk and sunflower oil, such as it can be mayonnaise, depended on protein content and pH (Anton, Chapleau, & Beaumal, 2001).

Total mesophilic bacteria were more sensitive to HPP at pH 3 than pH 7, at 200 MPa (29,010 psi) and 500 MPa (72,520 psi) during 10 min (**Figure 5**). The same synergetic effect between HPP and low pH was seen in molds and yeasts. In order to reach considerable inactivation levels in oil-water emulsions at neutral pH, it was necessary to increase pressure level. HPP at 500 MPa (72,520 psi) for 10 min permited a complete inactivation of total mesophilic bacteria, molds and yeast on a acidified emulsion (pH 3). Higher content of protein (5.5%) exerted a slight baroprotective effect on native microbiota.

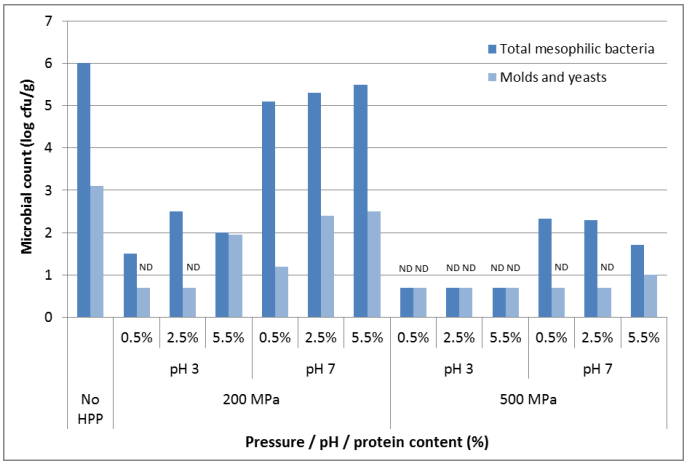

Figure 5. Inactivation of mesophilic bacteria, and molds and yeasts in HPP egg yolk emulsions (200 and 500 MPa, 10 min) at different pH (3 and 7) and protein content (0.5, 2.5 and 5.5%). ND: Not detected (Anton et al., 2001)

SENSORY QUALITY

HPP is a suitable technology for controlling microbial spoilage during long periods; however, when food products are microbiologically stable, the end of their shelf life is generally limited by changes in their sensory attributes.

Overall sensory quality

Since high pressure does not induce formation/destruction of new flavor-related compounds, organoleptic characteristics of the dressings, sauces and sandwich fillings will remain as the recently-prepared product does.

Mayonnaise-based fillings

Hirneisen et al. (2012) proved that HPP processing at 450 MPa (65,260 psi) for 5 min at 25 ºC (77 ºF) did not induce appreciable changes in sensory quality of mayonnaise-based seafood salads. The authors found than more of 2/3 of the untrained panelists (n=100) did not perceive differences between HPP-processed mayo-based and no HPP products.

Ranch dressing

Ranch dressing processed at 600 MPa (87,000 psi) for 5 min maintained its sensory quality after 26 weeks at refrigerated storage (Waite et al., 2009). Trained panelists (12 to 15 people) scored overall sensory quality of this dressing around 7 out 9-point test. They described the dressing after 26 weeks, as a good quality product, with mild odor and sour flavor, thick texture, no off-flavors and good color (**Figure 6**).

When HPP Ranch dressing is stored at 26 ºC (79 ºF) during 26 weeks, the dressing presented slight changes in color and odor, thick and creamy texture. Panelists scored it as "below good, above fair" sensory quality. Trained panelists scored its overall sensory quality around 6 out of 9, throughout storage (Waite et al., 2009).

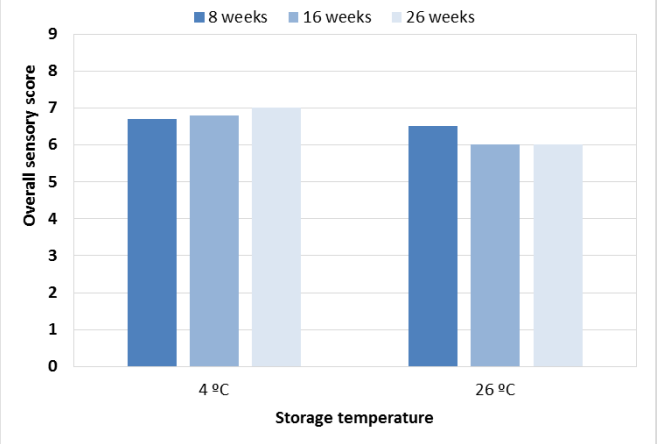

Figure 6. Sensory evaluation of HPP Ranch dressing (600 MPa, 5 min), storage at 4 ºC and 26 ºC during 26 weeks (Waite et al., 2009).

Color

When color is evaluated by spectrocolorimetry, the instrumental method was able to detect differences in color of HPP Ranch dressing during cold (4 ºC / 39 ºF) and room temperature (26 ºC / 79 ºF) storage compared to the fresh dressing immediately after HPP (Waite et al., 2009).

Refrigeration maintained color values of HPP dressing along 26 weeks. On the contrary, storage at 26 ºC (79 ºF) led to darker dressing (lesser L* values), in agreement with the description given by trained panelists (**Figure 7**). Changes in color were due to oxidation process of carotenoids (Waite et al., 2009).

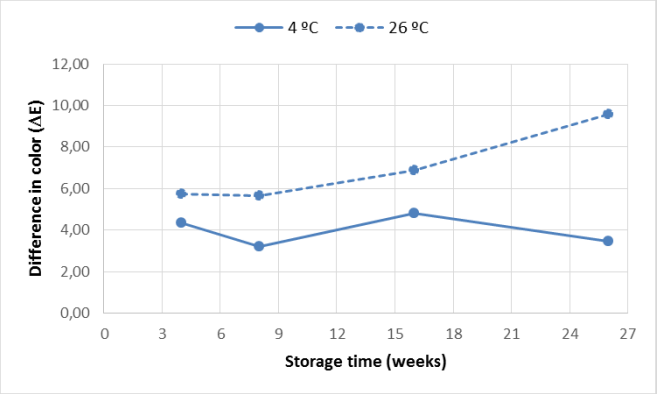

Figure 7. Evolution of difference in color determined by spectrocolorimetry of HPP Ranch dressing (600 MPa, 5 min) storage at 4 ºC and 26 ºC during 26 weeks (Waite et al., 2009).

Viscosity

Dressings, sauces and sandwich fillings based on emulsions are particularly sensitive to thermal treatments. Viscosity of emulsions sharply rises when emulsion is heated and proteins and polysaccharides start to form gels or coagulate (Anton et al., 2001). Thus, through HPP technology microbiological safe emulsions without significant texture modifications can be produced.

Anton et al. (2001) demostrated that HPP processing (500 MPa / 72,520 MPa, 10 min) do not induce significant changes in viscosity in oil-in-water emulsions (pH 3) at lower protein content than 5.50% compared to no-HPP emulsion (**Figure 8**). Untrained panelists were not able to detect difference in mouth feeling (texture) between HPP mayonnaise-based seafood salad (450 MPa / 65,260 for 5 min) and non-processed salad (Hirneisen et al., 2012).

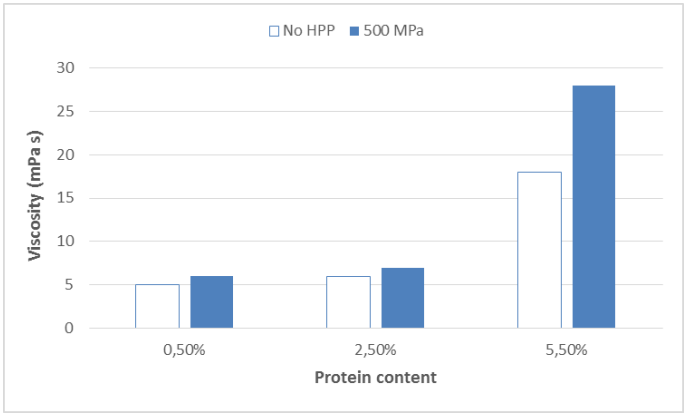

Figure 8. Viscosity of sunflower oil/egg yolk oil-in-water emulsion processed at 500 MPa for 10 min (10 ºC) at different protein content (Anton et al., 2001).

CONCLUSIONS

The effectiveness of high hydrostatic pressure to increase the shelf-life of these dressings, sauces and sandwich fillings without adding chemical preservatives and, at the same time, maintaining its sensory quality, has allowed for the expansion of HPP technology within this food industry.

The number and volume of food products processed by HPP is growing each day since the first commercial products in the last decade: sandwich fillings (2005, Spain); dressings (2007, USA); and sauces/dips (2008, USA).

A reflection of this is the growth of the number of our customers as such as this link shows: http://www.hiperbaric.com/en/customers

You can get more information about Hiperbaric and high pressure processing of foods on the next links:

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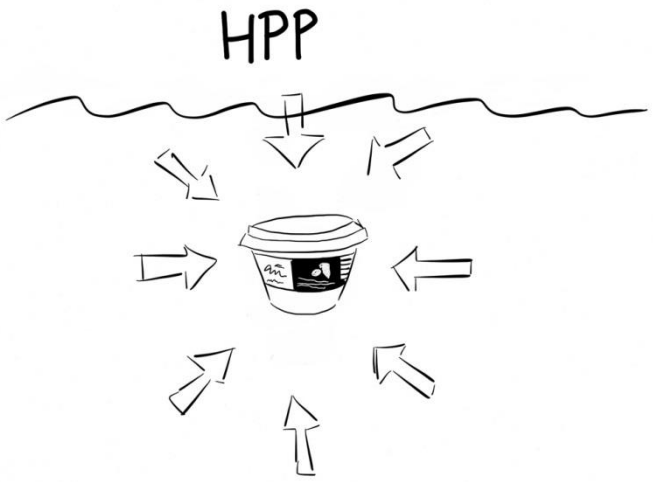

You can also contact us via e-mail. We are pleased to answer your questions.

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