HPP IN FRESH CHEESE

INTRODUCTION

High Pressure Processing (HPP) is a non-thermal food preservation technology that increases shelf life, ensures food safety of dairy products, including fresh cheese, while preserving premium quality and sensorial standards.

HPP technology is smoother than heat processing from the physicochemical point of view, since it doesn't create or break covalent bonds, there is not generation of new compounds by degradation of the molecules, as happen in conventional thermal processes. However, high pressures are capable of altering, breaking or creating weak bonds (electrostatic or hydrophobic interactions), present only in macromolecules such as proteins and polysaccharides (Cheftel, 1992). Thanks to this it is possible to inactivate microorganisms without altering the nutritional and sensory quality of the food. To control the growth of residual microbiota, as well as to slow down enzymatic reactions and sensory changes, fresh cheese should be stored at refrigeration temperature.

These are the reasons why HPP technology is beneficial for fresh cheese processing:

- Safer products with longer shelf life, due to inactivation of spoilage and pathogenic microorganisms.
- The sensory quality of the products is maintained after HPP processing.
- The nutritional quality of the cheese is not altered compared to unprocessed food.
- This technology allows to reduce and even avoid the use of preservatives and other chemical compounds.

SHELF-LIFE EXTENSION AND FOOD SAFETY

Given the current consumer demand for more natural and non-preservative foods, HPP technology is an effective method to reduce the microbial load without affecting the sensory quality of the product, reducing or eliminating the dependence on the use of preservatives.

Increase shelf life

Due to its physicochemical characteristics (slightly acid pH, high water activity, high protein content), fresh cheese is a food that allows the growth of microorganisms, mainly bacteria, yeasts and molds, which limit its shelf life.

Daryaei et al. (2008) demonstrated that pressures higher than 300 MPa/43,500 psi for 5 min inactivated more than 5 log of Lactococcus, a starter crop used in the production of fresh cheese. At 600 MPa, this microorganism was not able to grow at refrigerated storage conditions (4 ºC) for 8 weeks while controlling fermentation (Figure 1). In the same study, it was shown that cheese processed by HPP at 400 MPa and higher pressures for 5 min has a longer shelf life than unprocessed cheese, delaying yeast growth. In fresh unprocessed cheese, yeasts take 3 weeks to reach 5 log cfu/g, while at 400 and 600 MPa, this value is not reached during 8 weeks of storage (Figure 2).

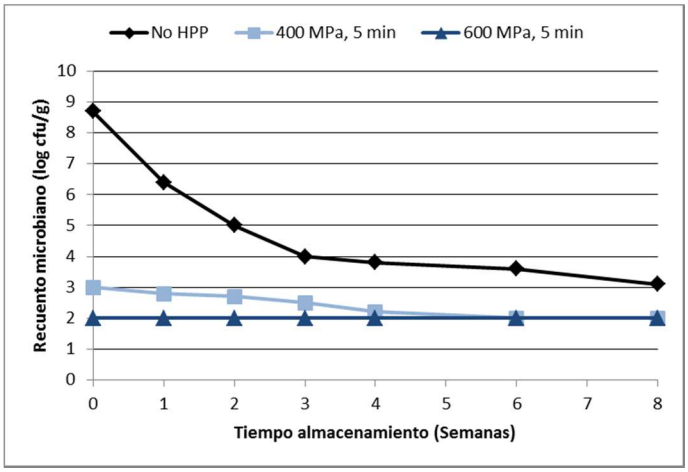

Figura 1. Evolution of *Lactococcus* in fresh cheese during 8 weeks of refrigerated storage after HPP (Daryaei et al., 2008)

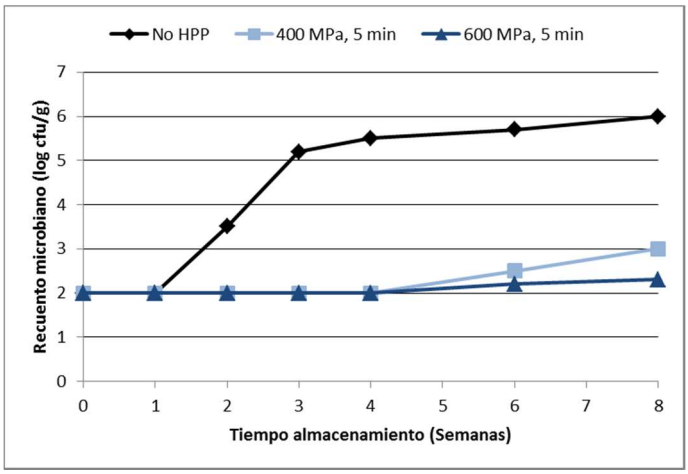

Figure 2. Yeast evolution in fresh cheese during 8 weeks of refrigerated storage after HPP (Daryaei et al., 2008)

Inactivation of pathogenic microorganisms

Recently, some outbreaks have been associated with cheese consumption around the world, as well as multiple product recalls due to the suspected presence of pathogenic microorganisms (Martínez-Rodríguez, Y. et al., 2012). Due to the effect at the structural and functional level exerted by high pressure on vegetative cells, which causes injury or even death, this technology has proven to be effective in the inactivation of pathogenic microorganisms. In the case of fresh cheese, HPP technology has been effective in *inactivating E. coli, Staphylococcus aureus, Yersinia entereocolitica, Salmonella enteritidis and Listeria monocytogenes*, as some studies

have shown (De Lamo-Castellví et al., 2005, 2006 and 2007; López-Pedemonte *et al*., 2007a and 2007b).

In Table 1, the different inactivation values of different pathogens inoculated in cheese at different pressure, time and temperature conditions can be observed (Martínez-Rodríguez, Y. *et al*., 2012). In general, high pressures allow between 4.7 to 7 log inactivation in fresh cheese of the most relevant foodborne pathogens.

The high water activity of fresh cheese, which makes it susceptible to the growth and development of microorganisms, allows high pressures to be effective in inactivating microorganisms, since the water in the food acts as a means of transmitting the pressure to the interior of the cell, causing cell death.

Inactivation of spores

HPP technology has proven to be effective in the inactivation of vegetative microorganisms in different food matrices. Regarding spores, a physiological state of some bacteria and fungi that allows them to survive in adverse conditions for long periods of time, high pressures allow the inactivation of fungal spores, reaching values of 6 log in the case of P. roqueforti in HPP cheese (400 MPa, 20 min; O'Reilly *et al*., 2000). However, bacterial spores are much more resistant, even to high-pressure processing, requiring pressures above 600 MPa for inactivation.

The problem caused by spores from a food safety point of view is related to the possibility of germination leading to bacterial development and growth and may be accompanied by toxin release (Linton *et al.* 2014). High-pressure technology can be combined with other strategies to prevent germination and even inactivate bacterial spores (Table 1). The application of some strategies may involve changes at the sensory level (pH reduction, addition of NaCl), or be regulated or limited by legislation (addition of nitrates and nitrites, addition of bacteriocins).

Table 1. Inactivation of pathogenic microorganisms in fresh cheese at different pressure, time and temperature conditions (Martínez-Rodríguez, Y. et al., 2012).

Pathogen	Conditions HPP	Inactivation (log ufc/g)
Salmonella Typhimurium	400 MPa/58.000 psi, 10 min, 20-25 °C	6
Salmonella Enteritidis		>6
Yersinia enterocolitica O:8		>5
Yersinia enterocolitica O:3		6
Yersinia enterocolitica O:1		>4
Listeria monocytogenes	500 MPa/72.500 psi, 10 min, 5-20 °C	5
Listeria monocytogenes		5
Staphylococcus aureus		>4
Staphylococcus aureus		6
Escherichia coli O157:H7		7
Escherichia coli O59:H21		7

Table 2. Strategies to control germination and to inactivate bacterial spores using HPP technology.

Germination control	
HPP + refrigeration	Temperature <3 °C
Reduction of pH+ HPP	Refrigeration + pH >5,0
	Stable product in environment (pH <4,6)
NaCl + HPP	NaCl >3,5%
Reduction of a_w + HPP	a_w <0,97
Inactivation of spores	
Antimicrobials + HPP	Compounds validation
	Addition of bacteriocins (nisin)
HPP + high temperature	Pressurization at 60-120 °C/140-250 °F

SENSORY QUALITY

Since HPP technology does not create or break covalent bonds, there is no generation of new compounds by degradation of molecules, as occurs in conventional thermal processes, it is considered that this method of preservation does not modify the sensory attributes of foods. However, high pressures are capable of modifying the three-dimensional structure of proteins and polysaccharides (Cheftel, 1992), so that some sensory aspects may be altered.

Color and appearance

A sensory panel composed of 10 trained panelists detected no differences when comparing the color, moisture and "oiliness" of HPP processed cheese (400 MPa, 20 min, 20 ºC) with the characteristics of fresh cheese. The HPP cheese presented a more homogeneous appearance (Sandra *et al*, 2004). The same panel evaluated the appearance of the cheese after a breakage test, without detecting significant differences between the two cheeses in terms of particle size.

Textura

Sandra *et al* (2004) evaluated texture changes in fresh cheese using instrumental techniques as well as by a trained sensory panel. Both analytical techniques showed texture changes in fresh cheese processed by high pressure (400 MPa, 20 min, 20 ºC). In general, the HPP cheese presented higher firmness, gumminess and chewiness, when texture was evaluated instrumentally. However, the panel of tasters detected differences in elasticity and cohesiveness.

Textural changes are mainly due to changes in the 3D structure of casein, a protein present in cheeses, which forms a protein network that gives the cheese its microstructural properties, which have an impact on the sensory quality of the product. It is possible to minimize the sensory impact of changes at the cheese structural level caused by high pressure by optimizing the pressure and time parameters.

CONCLUSIONS

High pressure technology or HPP allows the control of altering and pathogenic microorganisms in fresh cheese, making it possible to produce a safer product with a longer shelf life. In addition, the application of this technology in combination with other strategies allows the control of spores in these products.

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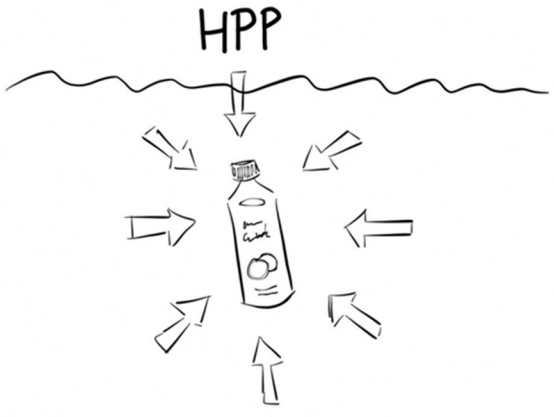

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