HPP RAW MEAT PRODUCTS

INTRODUCTION

High Pressure Processing (HPP) is a non-thermal food processing technology used for raw meat products, either they are minced, sliced or whole pieces, with longer shelf-life and safer. On this sector, the pressure range used it is between 200 MPa (2,000 bar; 29,000 psi) and 600MPa (6,000 bar; 87,000 psi) applied at refrigerated temperature.

Three are the main applications of high pressure processing on raw meat:

- On the range from 400 MPa (4,000 bar; 58,000 psi) and 600 MPa (6,000 bar; 87,000 psi), shelf-life and safety of raw meat products food products is improved, inactivating spoiling vegetative microorganisms (bacteria, yeasts and molds) and pathogens. High pressure is applied on the final package, so recontamination after processing is avoided.
- Tenderization: Pressures on the range from 200 MPa (2,000 bar; 29,000 psi) to 400 MPa (4,000 bar; 58,000psi) allow improving texture and organoleptic characteristics on raw pieces.
- Reduction of cooking losses: Pressures on the range from 200 MPa (2,000 bar; 29,000 psi) to 400 MPa (4,000 bar; 58,000psi) allow enhancing meat binding.

FOOD SAFETY AND SHELF-LIFE

Shelf life increase without changing sensorial quality of the final product is the aim of many manufacturers. Chemical preservatives are used to be the main method to increase raw meat products shelf life. High pressure allows manufacturer to reach an *all-natural* or *additive-free* product safer and with longer shelf life. Also, microorganism inactivation achieved by HPP avoids safety problems caused by undercooking.

Since in 2001, the US FDA evaluated some strategies for microbial inactivation and stated: "Ground beef can be pasteurized by HPP to eliminate *E. coli O157:H7*, *Listeria* spp., *Salmonella* spp., or *Staphylococcus* spp."(Parker *et al*). Application of HPP on fresh meat market has grown significantly.

HPP raw meat has intact the quality parameters throughout their shelf-life. According to M. Martin, 2011, HPP burgers maintain the quality parameters up to 42 days meanwhile control (no HPP) burger quality start to decrease on day 7.

Regarding the results obtained by Kurk *et al.* (2011) in the challenge study performed with chicken breast filet stored at 4ºC (39ºF) after HPP and (table 1), pressure of 450 MPa (4,500 bar; 65,267 psi) and 600 MPa (6,000 bar; 87,000 psi) during 5 min inactivated more than 5 log ufc/g of *E. coli, Listeria monocytogenes and Salmonella typhimurium*. After High pressure processing at 600 MPa (6,000 bar; 87,000 psi) during 5 min *E. coli* and *S.typhimurium* population stayed below detection level (10 cfu/g)for at least 7 days and *Listeria monocytogenes* for 14 days, despite of the high initial contamination (6 to 8 logcfu/g)

Pathogen	Conditions (MPa)	Storage (days)			
		0	3	7	14
E.coli	Control (No HPP)	8.45	7.98	7.84	8.01
	450 MPa	ND	ND	1.30	3.62
	600 MPa	ND	ND	ND	1.95
S.typhimurium	Control (No HPP)	6.17	6.74	6.69	6.84
	450 MPa	2.82	ND	1.48	1
	600 MPa	ND	ND	ND	1
L. monocytogenes	Control (No HPP)	7.35	6.08	5.63	6.92
	450 MPa	ND	ND	ND	ND
	600 MPa	ND	ND	ND	ND

Table 1: Effects of high pressure processing during 5 min on microbial population (log CFU/g) of chicken breast fillet during storage at 4ºC. (ND: Not detected <10 cfu/g) (Kruk *et al*., 2011)

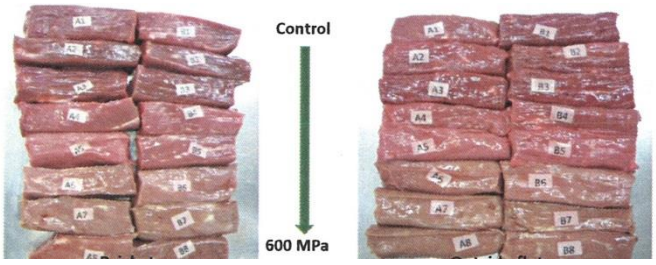

Figure 1: Portions of brisket (left) and outside flat (right) beef muscle after high pressure process (up to 600 MPa) for 5 min. (Sikes and Warner, 2011)

TENDERIZATION

Pressures higher than 400 MPa (4,000 bar; 58,015 psi) can lead to denaturation of proteins responsible of color and texture on meat, so changes in color of fresh meat can be observed, usually described as "white/opaque" appearance (figure 1), as well as reduction of hardness.

On the contrary, pressures of 100 MPa (1,000 bar; 14,500 psi) to 200 MPa (2,000 bar; 39,000 psi) applied to pre-rigor mortis meat, for 2 min lead in to an increase of glycolysis rate, carrying a fast pH drop (figure 2). Consequently, fresh meat going into rigor state immediately, with massive meat fibre contraction (about 40%) and increasing of tenderness. McFarlane *et al.* (1973)

Sensory analysis performed by McFarlane (1973) confirmed laboratory results (Table 2). The panel evaluated the samples and concluded that pressurized muscles at 103 MPa (1,030 bar; 15,000 psi) for 2 min were tenderer, juicier and more acceptable than control samples, i.e. non-pressurized samples.

McKeena (2009) performed some experiments, which results are represented in figure 3. Tenderization was determined by slice-shear- force measurement. Fresh meat (beef strip loin steaks) was vacuum-packaged and subjected to 275 MPa (2,750 bar; 40,000 psi) and immediately depressurized. In one batch, this cycle was repeated two times (HPPx2) and on the other batch the cycle was repeated five times (HPPx5). Results provided by the author indicated that HPP avoided proteolytic degradation of prerrigor meat up to day 14. This inactivation of n-calpain avoided postmortem aging. Briefing, pressures around 275 MPa (2,750 bar; 40,000 psi) lead to stop glycolysis and allows obtaining tender meat products with higher water holding capacity and fat binding properties; these properties would be appreciated in further processes as we will explain afterwards.

REDUCING COOKED LOSSES

Sikes *et al.* (2009) demonstrated that cook loss might be reduced by using HPP. On this study, *post-rigor* raw meat batters were manufactured from retail beef minced meat using different NaCl concentrations (0–2%), and were packed into casings and subjected to high pressure processing up to 400 MPa (4,000; 58,000 psi) for 2 min at refrigerated temperature (10ºC, 50ºF). After HPP process, sausages were

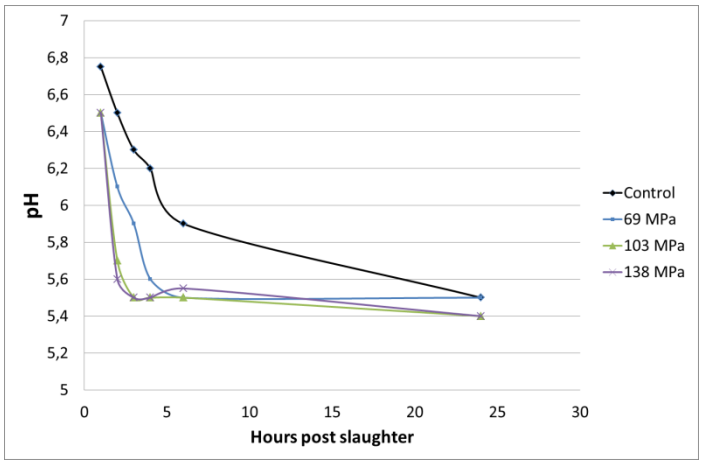

Figure 2: Effect of different pressure applied for 4 min, on the pH of ox longissimus dorsi sheep muscle stored at 25ºC. (McFarlane, 1973)

Property	Mean taste panel score			
	Sememembranosus		Longissimus dorsi	
	Control	HPP	Control	HPP
Tenderness	3.2	5.2	4.5	7.4
Juiciness	6.8	6.2	6.6	5.8
Acceptability	5.0	6.6	6.1	8.3

Table 2: Taste panel scores for tenderness, juiciness and acceptability of pressurized (103 MPa, 2 min) and non-pressurized (control) longissimus dorsi and semimembranosus muscles of sheep. (Mcfarlane, 1973)

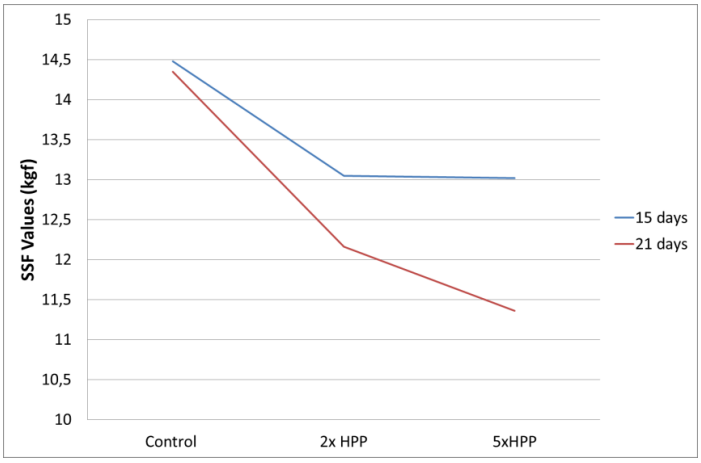

Figure 3: Relationship between HPP (275 MPa several cycles) and slice-shear force (SSF) of beef strips loin steaks. (McKeena,2009)

cooked up to reach a core temperature of 72ºC (161ºF) and then cooled down.

Quality of meat batters is strongly dependent upon several physicochemical characteristics, such as pH or salt concentration. In this study, meat batter pH was 5.6 to 5.8, and NaCl concentration was variable, from 0% to 2%. In figure 4, cook losses *vs.* pressure (during a holding time of 2 min) is represented. Processing conditions of 200 MPa (2,000 bar; 29,000 psi) held for 2 min reduced cook losses around 20 % (from 30% to less than 10%, as shown in figure 4). The level of salt has a beneficial effect on cook loss reduction which is positive if manufacturer wants to develop salt reduced products

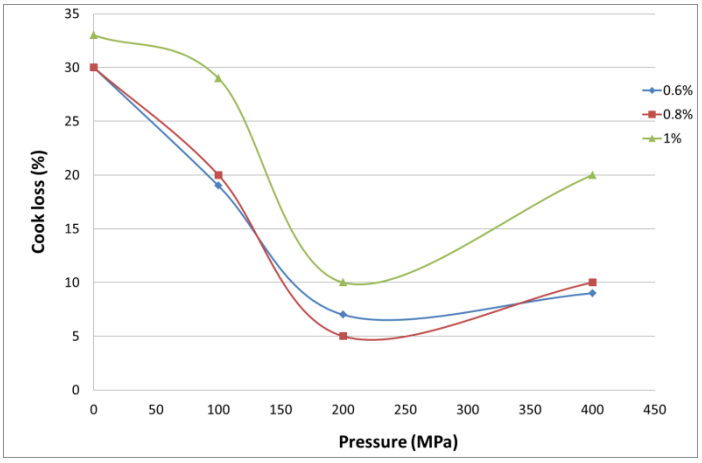

Figure 4: Changes in cook losses of pressure processed beef batters containing various NaCl concentrations, subjected to different pressures during 2 min. (Sikes *et al.* 2009)

CONCLUSIONS

Fresh meat products sector have started to implement new preservation technologies such as high pressure processing to reach safer products with longer shelf life. First raw meat based product was launched in Europe in 2008, with an extended shelf life when compared with non-pressurized ones.

Tenderization is a novel application to be implemented in meat industry. Value added cuts may be obtained with this technology.

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

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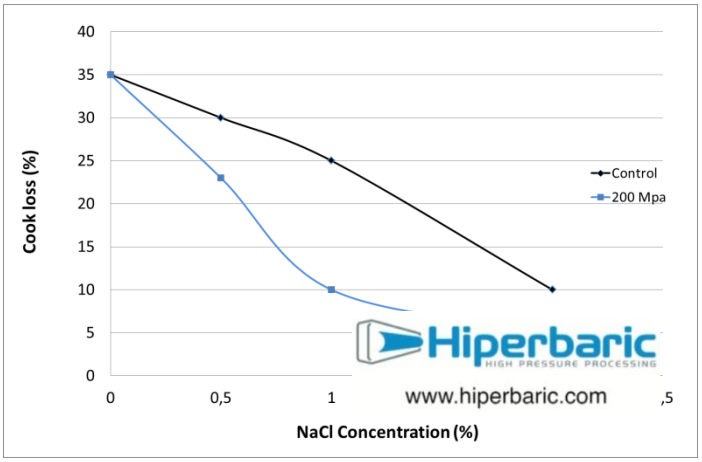

Figure 5: Changes in cook losses of pressure processed beef batters containing various NaCl concentrations subjected to 200 MPa for 2 min. (Sikes *et al.* 2009)

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