HPP ON RAW CHICKEN MEAT

INTRODUCTION

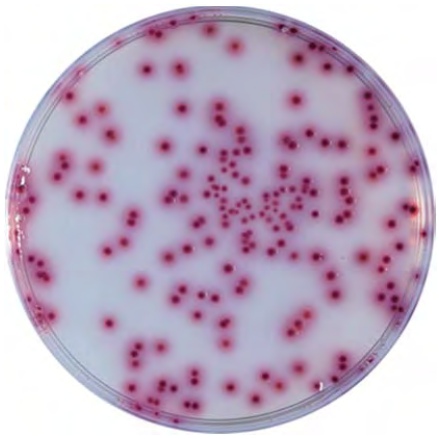
High Pressure Processing (HPP) is a non-thermal food processing technology used for raw meat, either they are minced, sliced or whole pieces, with longer shelf-life and safer. On this sector, the pressure range used it is between 29,000 psi (200 MPa) and 87,000 psi (600MPa) applied at refrigerated temperature.

Currently, three are the main applications of high pressure processing on raw meat:

- Safety and shelf-life of raw meat products food products is improved On the range from 400 MPa (4,000 bar; 58,000 psi) and 600 MPa (6,000 bar; 87,000 psi), , 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 (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 (29,000 psi) to 400 MPa (4,000 bar; 58,000psi) allow enhancing meat binding.

FOOD SAFETY OF RAW CHICKEN MEAT

Salmonella contamination in food, especially poultry meat, is one of the relevant foodborne pathogens worldwide. HPP technology has demonstrated to be one of the suitable technologies for inactivating this pathogen in various model systems and meat products.



However, research has shown that food matrix, its components and its physicochemical characteristics such as pH and water activity (a_w), plays a relevant role in the inactivation of microorganisms by HPP, exerting a protective effect on microorganisms or enhancing inactivation level by HPP. Besides the characteristics of food matrix, variation in pressure resistance among serotypes of *Salmonella* was reported. The research of Alpas and others (1999) showed that *Salmonella enteriditis* FDA and *Salmonella typhimurium* E21274 were the most resistant serotypes in peptone solution at 345 MPa (50,040 psi, 25 ºC (77 ºF) for 5 min, with an inactivation level of 5.45 and 5.71 log CFU/ml, respectively.

Thus, this whitepaper summarizes the results of inactivation of *Salmonella* in HPP raw chicken meat of two scientific papers done by Kruk and others (2011) and Tananuwong and others (2012). Both studies evaluated the inactivation of *Salmonella* Typhimurium by HPP and the impact of HPP processing on sensory quality of the product.

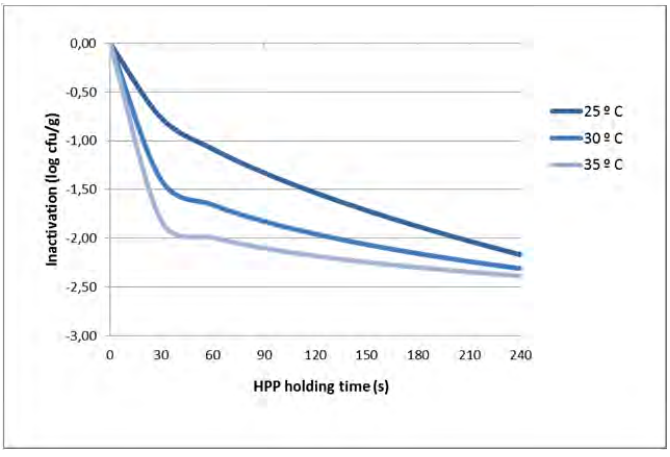


Figure 1. Inactivation of *Salmonella* typhimurium in HPP raw chicken breast fillets at 300 MPa (43,500 psi) at different holding time and temperature (Tananuwong and others, 2012)

Inactivation of *Salmonella* in chicken meat

Tananuwong and others (2012) tested several HPP conditions: pressure level, holding time, and pressurization temperature (25, 30 and 35 ºC / 77, 86 and 95 ºF). They evaluated the instantaneous

inactivation of *Salmonella* Typhimurium at the different HPP conditions (**Figure 1** and **Figure 2**). Pressure level had a significant impact on inactivation of the pathogen in raw chicken meat. Increasing pressure level led to lower *Salmonella* survivals. The increase of pressure from 300 to 400 MPa (43,500 to 58,000 psi) doubled maximum inactivation levels from 2.0 to around 4.0 log CFU/g.

Increasing holding time and temperature led to higher inactivation levels, as well. However, the impact of these processing parameters was lower than the increase of pressure level (< 1 log cfu/g).

Any preservation technology should inactivate the target microorganisms and avoid the growth of the survival microorganisms. Thus, it is necessary to trace the bacteria after HPP and throughout storage. The study done by Kruk and others (2012) evaluated the evolution of *Salmonella* Typhimurium in HPP chicken breasts for two weeks at refrigeration at different pressure levels (300, 450 and 600 MPa / 43,510; 62,265 and 87,020 psi)) for 5 min (**Figure 3**).

Increasing the pressure above 300 MPa (43,510 psi) improved instantaneous lethal effect of HPP on *Salmonella.* At 450 MPa (62,265 psi) and higher pressures HPP reached around 4-log inactivation throughout cold storage, avoiding recover of bacteria. The impact of the increase of pressure on lethality of *Salmonella* in raw meat is in agreement with the study of Tananuwong and others.

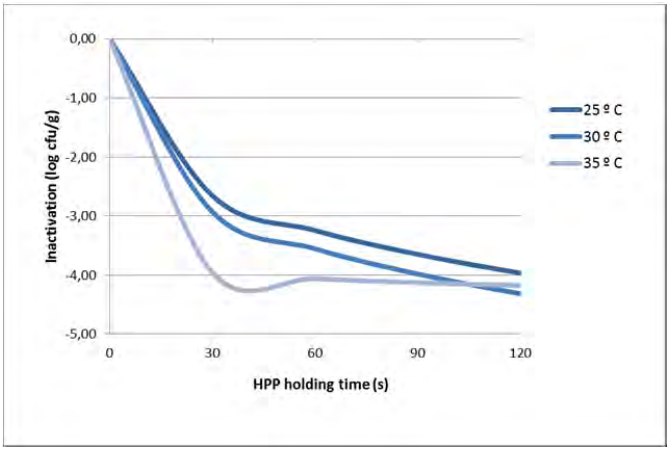


Figure 2. Inactivation of *Salmonella* typhimurium in HPP raw chicken breast fillets at 400 MPa (58,000 psi) at different holding time and temperature (Tananuwong and others, 2012)

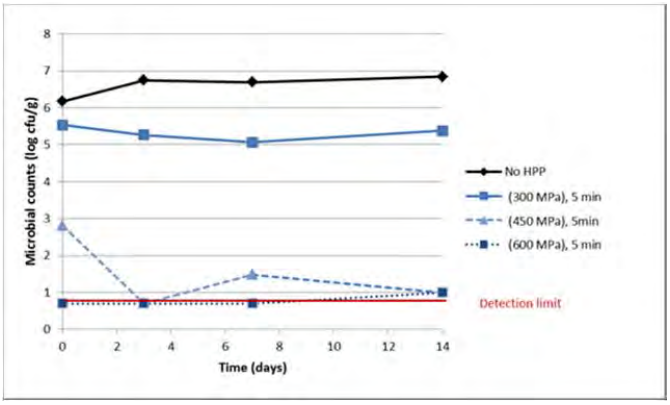


Figure 3. Evolution of *Salmonella* Typhimurium in HPP chicken breast fillets during refrigerated storage (4 ºC)) (Kruk and others, 2011)

SENSORY QUALITY OF HPP CHICKEN MEAT

HPP is able to break, or create, weak bonds (hydrophobic and electrostatic interactions), only present on macromolecules (Cheftel, 1992). Thanks to this phenomenon, HPP can inactivate microorganisms, denaturing their cell membrane proteins. However, pressure can affect other proteins, including those related to meat color and texture. Pressures higher than 400 MPa (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, as well as an increase of hardness.

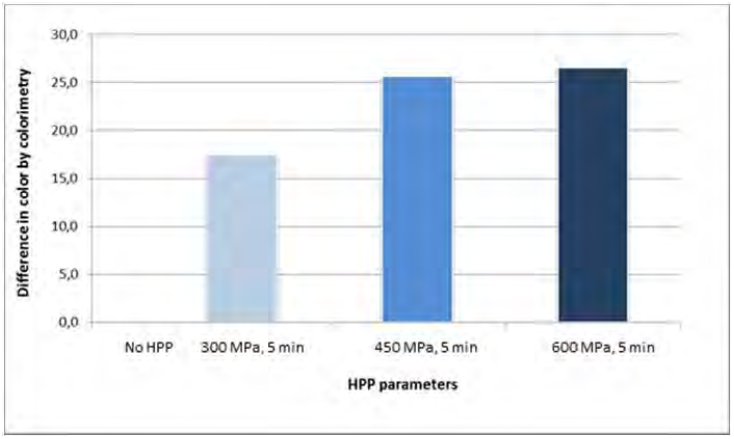


Figure 4. Difference in color (evaluated by colorimetry) of HPP chicken meat at different pressure levels compared to no HPP meat. (Difference in color for no HPP samples = 0) (Kruk and others, 2011)

HPP on chicken meat color

The discoloration of meat is due to myoglobin denaturation and/or heme displacement or release as well as ferrous oxidation caused by high pressure (Carlez and others, 1995). The content of myoglobin in chicken meat is lower than beef or pork. Therefore, the effect of pressure, especially on redness of the muscle could be not as well pronounced in chicken breast fillets.

The study of Kruk and others (2011) showed that the increase of pressure entails a difference in color compared to non-HPP chicken breast fillets evaluated by colorimetry (**Figure 4**). This instrumental technique allows the measurement of color intensity quantitatively in a higher sensitive way than human eye and reducing human perception bias. HPP-processed chicken meat becomes whiter and redder compared to no HPP meat. The intensity of these changes in color is increase at higher pressures.

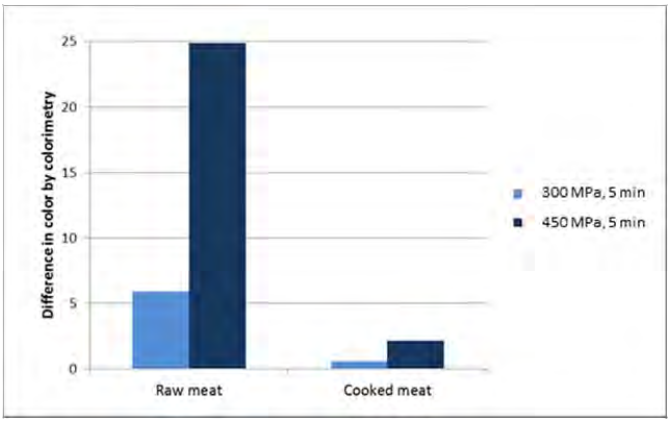


Figure 5. Difference in color (evaluated by colorimetry) of HPP chicken meat at different pressure levels compared to no HPP meat before and after cooking (Difference in color for no HPP samples= 0) (Tananuwong and others, 2012)

Despite of the significant change in color of HPP raw chicken meat, there was no significant differences in meat color after cooking of HPP chicken meat compared to cooked no-HPP meat according to Tananuwong and others (2012) (**Figure 5**).

HPP on other sensory attributes of chicken meat

Effect on meat aroma and flavor

HPP induces changes in aroma profile of the chicken breast meat, delaying the development of volatile basic nitrogen (VBN), improving meat freshness (**Table 1**). However, HPP increased slightly lipid oxidation (TBARS) of fresh meat at 87,000 psi for 5 min (Kruk and others, 2011), which can lead to rancid flavor.

Tananuwong and others (2012) found HPP kept aroma intensity of fresh raw meat evaluated by panelists (**Figure 6**). Similar result was found regarding meat flavor in the same study.

Effect on meat texture

Since high pressure can modify protein structure, texture is one of the sensory attributes which can be affected in raw meat. Kruk and others (2011) found a significant increase in hardness, cohesiveness, gumminess and chewiness in HPP fresh chicken breast fillets at pressure processing above 300 MPa (43,510 psi) for 5 min (**Table 1**).

Panelists scored the juiciness slightly lower HPP chicken meat compared to no HPP samples (**Figure 6**). However, the difference in juiciness was only significant in chicken meat processed at 300 MPa (43,510 psi). At higher pressures, there was no statistical difference compared to non-HPP meat

Table 1. Comparison of quality traits of HPP chicken breast fillets and no HPP meat (Kruk and others, 2011)

		No HPP	300 MPa 5 min	450 MPa 5 min	600 MPa 5 min
Physical character.	Moisture (%)	70,3	72,2	72,7	73,8
	Cooking loss (%)	31,6	30,4	33,7	37,8
Spoilage-relate volatile compound	VBN (day 3)	27,1	17,5	16,1	14,0
	VBN (day 7)	66,3	34,3	25,9	19,6
	TBARS (day 0)	0,28	0,27	0,62	1,17
	TBARS (day 3)	0,48	0,43	0,66	1,75
	TBARS (day 7)	0,47	0,73	0,75	2,32
Texture	Hardness	28,0	30,1	44,8	50,7
	Cohesiveness	0,17	0,25	0,27	0,32
	Gumminess	4,9	7,8	12,3	16,2
	Chewiness	1,77	2,72	4,43	6,7

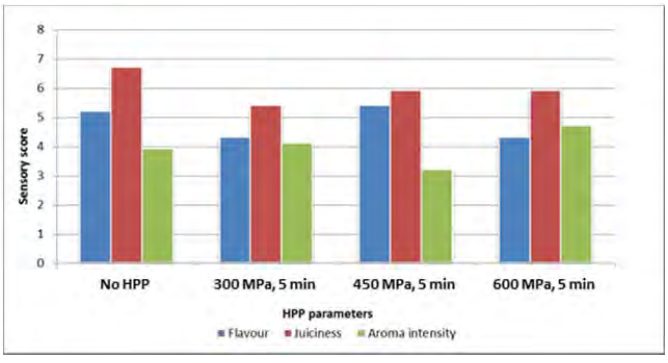


Figure 6. The effect of high pressure processing on flavour, juiciness and aroma intensity of chicken breast fillet evaluated by sensory panelists (Kruk and others, 2011)

(Kruk and others, 2011). The same researchers stated other sensory attributes such as meat color, texture, tenderness, aroma pleasantness and overall satisfaction were not affected by pressure.

CONCLUSIONS

HPP technology is a suitable processing method for inactivating *Salmonella,* even pressure-resistant serotypes such as *S.* typhimurium, and other relevant foodborne microorganisms in raw chicken meat. However, if the required HPP processing conditions are intense for controlling *Salmonella,* HPP could induce changes in sensory attributes, mainly those related to product appearance. The other sensory attributes and the overall sensory quality are slightly or not affect by HPP processing.

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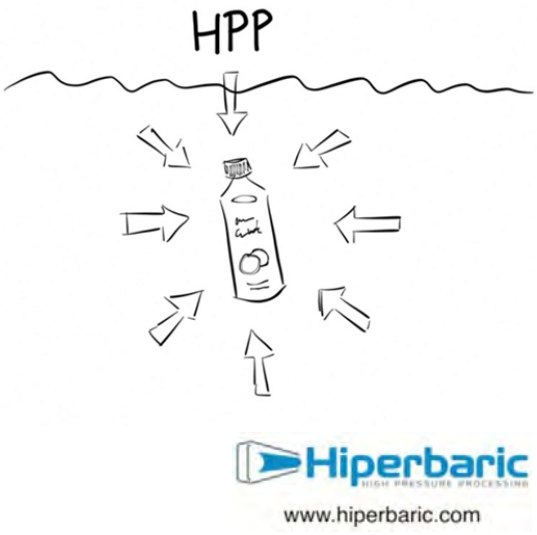

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