

Effect of High Hydrostatic Pressure against *Listeria monocytogenes* present on Ready To Eat meal

David Navarrete Motilla

This review summarizes the current studies regarding *Listeria monocytogenes* reduction applying HPP, alone or in combination with other hurdles, and the factors that can affect to this reduction in RTE products.

Table 1. Reported hospitalisation and case-fatality rates in human due to zoonoses (UE27), 2012

illness	Number of confirmed cases	Hospitalization rate (%)	Case-fatality rate (%)	Reported deaths
Campylobacteriosis	214.268	47,7	0,03	31
Salmonellosis	91.034	45,1	0,14	61
VTEC infections	5.671	36,5	0,36	12
Listeriosis	1.642	91,6	17,8	198
Yersiniosis ^a	7.017	55,2	0,02	1

EFSA. 2014.

^a2011 data

Figure 1. Colour changes on raw meat (McArdle *et al.* 2010).

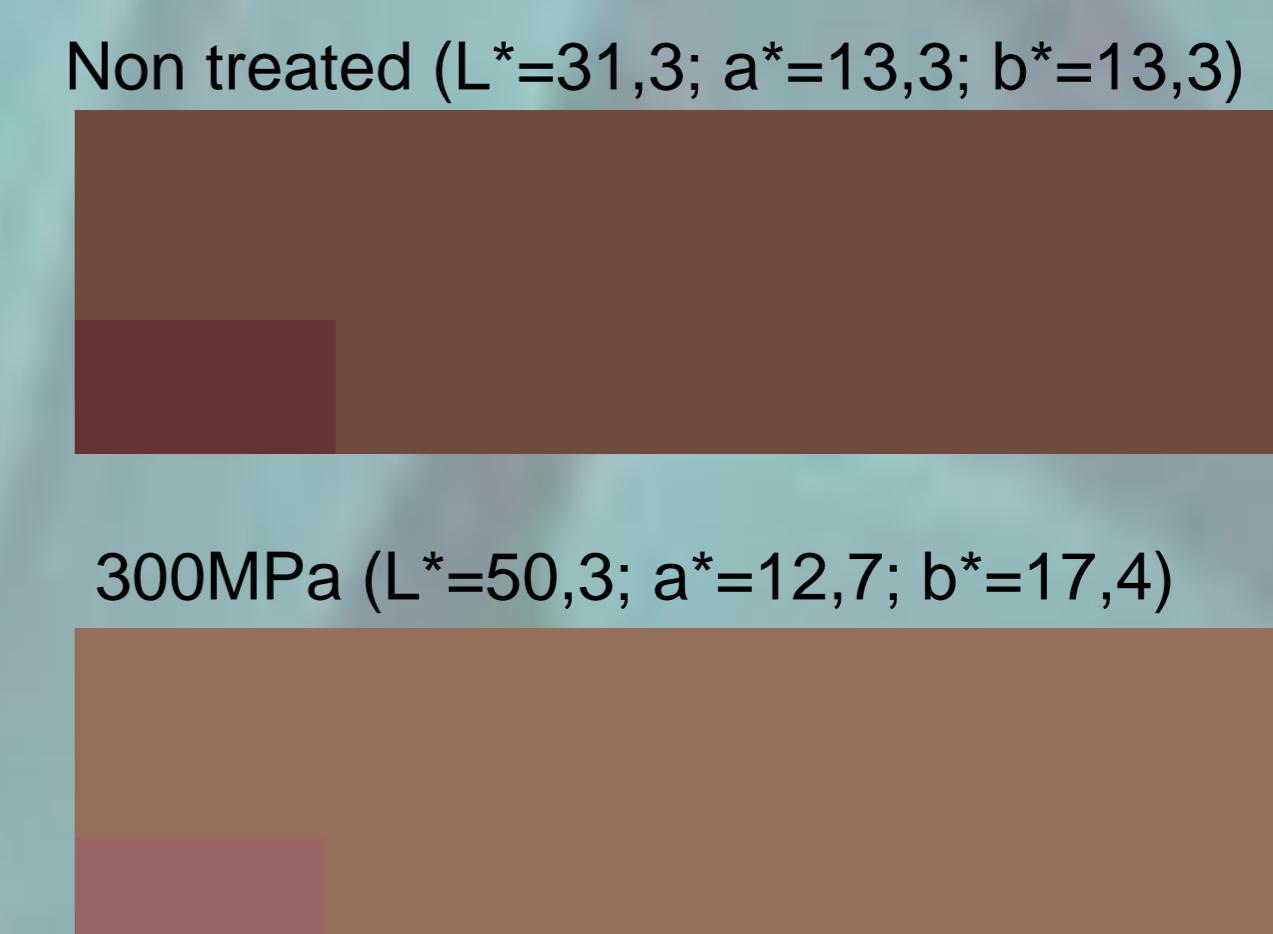


Table 2. *Listeria monocytogenes* reductions on several RTE products regarding the HPP treatment and in combination with other hurdles.

RTE product	Pressure (MPa)	Time (min.)	Temperature (°C)	Log reduction (ufc/g)	Treatment combination	Shelf life or lag phase elongation (days)	Source
Cooked ham	400	10	17	2,5-3,4		20 (6°C) ^c	(Marcos <i>et al.</i> 2008)
Cooked ham	400	10	17	2,5-3,4	Enterocins	40 (6°C) ^c	(Marcos <i>et al.</i> 2008)
Cooked ham	400	10	17	2,5-3,4	Lactate+diacetyl ^b	60 (6°C) ^c	(Marcos <i>et al.</i> 2008)
Cooked ham	600	6	31	3,5 ^d		>120 (4°C) ^{bc}	(Jofré <i>et al.</i> 2009)
Dry-cured ham	600	6	31	3,5 ^d		>120 (4°C) ^{bc}	(Jofré <i>et al.</i> 2009)
Pernil sec curat	600	5	15	7	Nisin	>60 (8°C) ^b	(Hereu <i>et al.</i> 2012a)
Dry-cured ham (4% salt)	750	5	21	5,27			(Bover-Cid <i>et al.</i> 2011)
Marinated beef loing	600	6	31	3,5 ^d		>120 (4°C) ^{bc}	(Jofré <i>et al.</i> 2009)
Cooked turkey	400	2	4	3,8			(Juck <i>et al.</i> 2012)
Cooked turkey	600	2	4	5,1			(Juck <i>et al.</i> 2012)
Vienna sausages	500	1	25	>5 ^d	<i>Lactobacillus casei</i>		(Chung <i>et al.</i> 2010)
fish slurry (mackerel)	400	7	20-25	>5			(Ramaswamy, 2008)
Trout ^a	414	5	20	>4			(Basaran-Akgul <i>et al.</i> 2010)
Trout ^a	517	5	20	>5			(Basaran-Akgul <i>et al.</i> 2010)
Trout ^a	414	5	20	>2	1-3% salt		(Basaran-Akgul <i>et al.</i> 2010)
Trout ^a	517	5	20	>8 ^d	1-3% salt		(Basaran-Akgul <i>et al.</i> 2010)
Smoked salmon	200	180	-18	4,28	-18°C; pH=7		(Ritzet <i>et al.</i> 2008)
Smoked salmon	200	180	4°C	4,89	pH=4,5		(Ritzet <i>et al.</i> 2008)
Smoked salmon	200	180	-18	8,97 ^d	-18°C; pH=4,5		(Ritzet <i>et al.</i> 2008)
brain-heartinfusion	400	10	15	>8-9 ^d		7 ^b	(Jofré <i>et al.</i> 2010)
brain-heartinfusion	900	10	15	>8-9 ^d		>21 ^b	(Jofré <i>et al.</i> 2010)
Apple juice	375	20	20	<1			(Espina <i>et al.</i> 2013)
Apple juice	375	20	20	>5 ^d	Essential oils (200μL)		(Espina <i>et al.</i> 2013)
Raw milk (to Camembert milk)	500	10	20	>4 ^d			(Linton <i>et al.</i> 2008)
Fresh cheese	500	15	18	>5			(Arriagada, 2013)
							(Hnosko <i>et al.</i> 2012)

^aOncorhynchus mykiss

^bShelf life

^cLag phase

^dReduction below limit detection

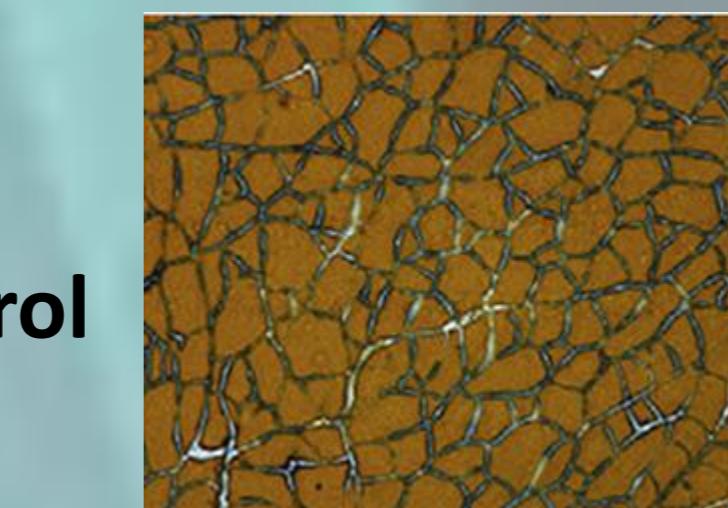
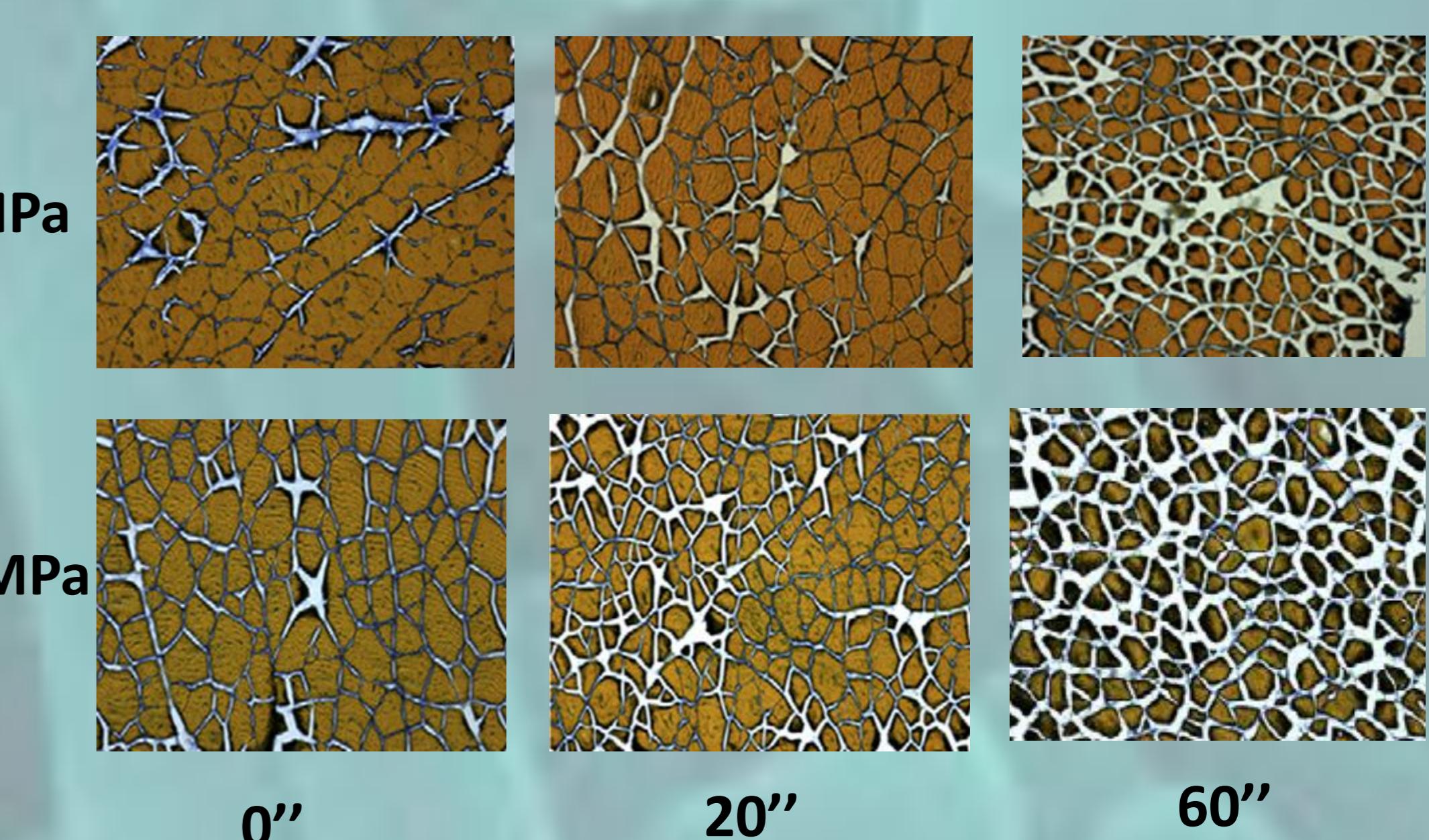


Figure 2. Texture comparison between several HPP treatments on smoked salmon. Adapted from Gudbjorndottir *et al.* (2010).



Changes on textural characteristics are more influenced by application time of HPP than pressure level on salmon.

Conclusions

-Listeriosis are rising in the recent years in the EU27.

-RTE products, both for their intrinsic and extrinsic characteristics, are risk products as *Listeria monocytogenes* vector.

- HPP is an effective alternative no-thermal treatment to remove or reduce *Listeria monocytogenes* risk, and applied with **hurdle treatments** as **bacteriocins** (e.g. enterocins or nisin), **bacteria competitors** that survive HPP (mainly Lactic Acid Bacteria –LAB- like *Weissella viridescens* or *Lactobacillus casei*), **essential oils** (e.g. *Citrus reticulata* or *Thymus algeriensis*), or their pure components (e.g. limonen or carvacol), **temperatures below 0°C or low pH** decreases counts after treatment, prevents the recovery of cells with sublethal damage or prolong the lag phase of *Listeria monocytogenes* and shelf life at several temperatures, with consequent economic benefit.

-The companies that apply HPP should be aware that: (i) **baroresistance of *Listeria monocytogenes* increases in stress conditions** prior to HPP and depending on the HPP conditions, (ii) there are significant differences between the reductions depending on food matrix, so it is advisable to do Challenge test by product (or when formulation changes are done), (iii) depending on de culture medium the *Listeria monocytogenes* recovery is different and (iv) cells with sublethal damage may grow at long term if no additional hurdles are applied.

Table 3. Factors that increases the *Listeria monocytogenes* baroresistance

Factor	Increases the baroresistance	Decreases the baroresistance	Source
Growth phase	Stationary phase	Log-phase	Rendueles <i>et al.</i> 2011; Shearer <i>et al.</i> 2010
Growth temperature	40-43°C	10-25°C	Juck <i>et al.</i> 2012; Shearer <i>et al.</i> 2010
Aw	High (Aw<0,86-0,83)	Low (Aw>0,86)	Hayman <i>et al.</i> 2008a
Thermal shock	YES (e.g. 48°C; 5 minutes)	NO	Hayman <i>et al.</i> 2008b
Treatment temperature of HPP	Room temperature	T ^a >40 T<0C	Rendueles <i>et al.</i> 2011