

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

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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. ^a 2011 data				

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

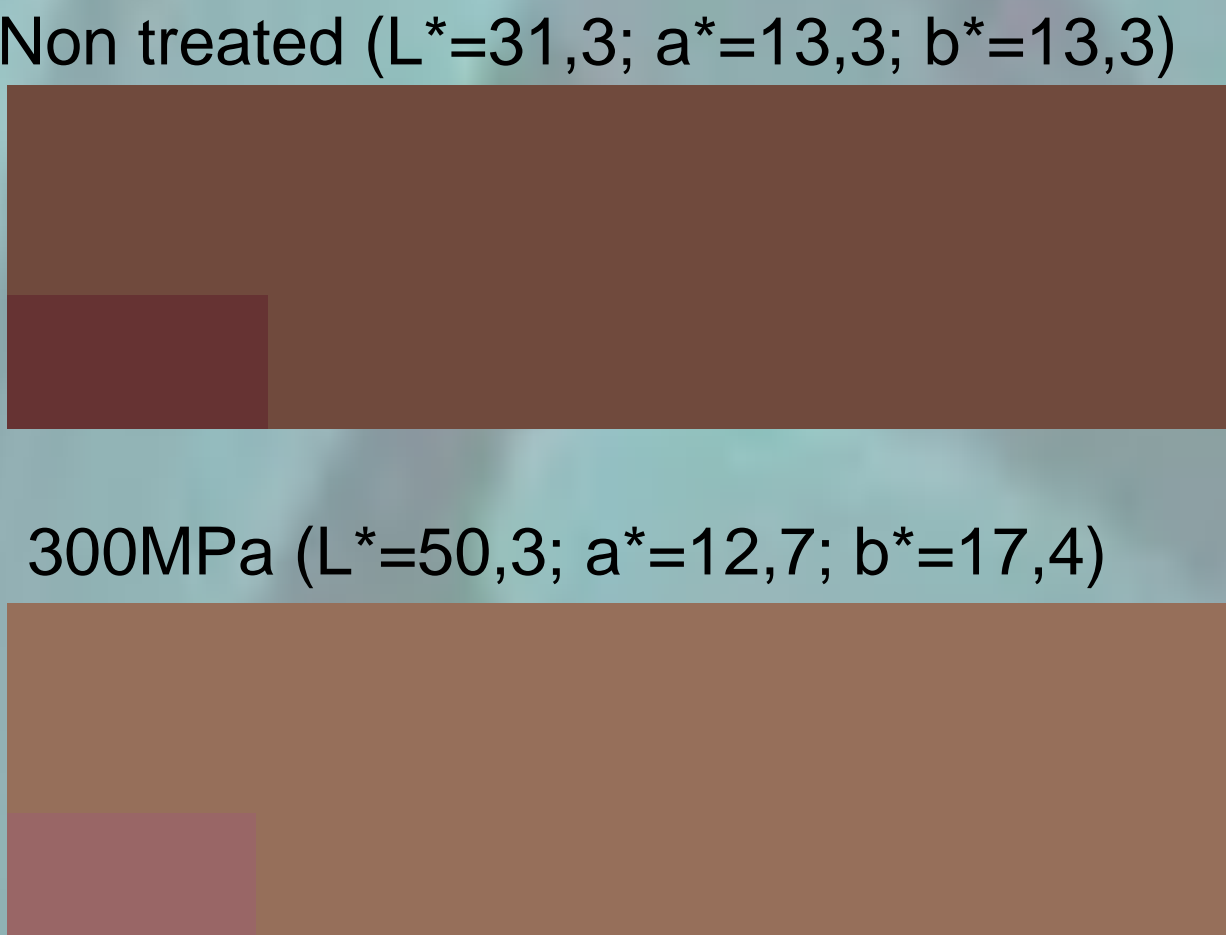


Table 2. *Listeria monocytogenes* reductions on several RTE products regarding the HPP treatment and in combination with other hurdles.

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+diacetate ^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	Nisina	>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	8,91 ^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)

^a*Oncorhynchus mykiss*
^bShelf life
^cLag phase
^dReduction below limit detection

Control

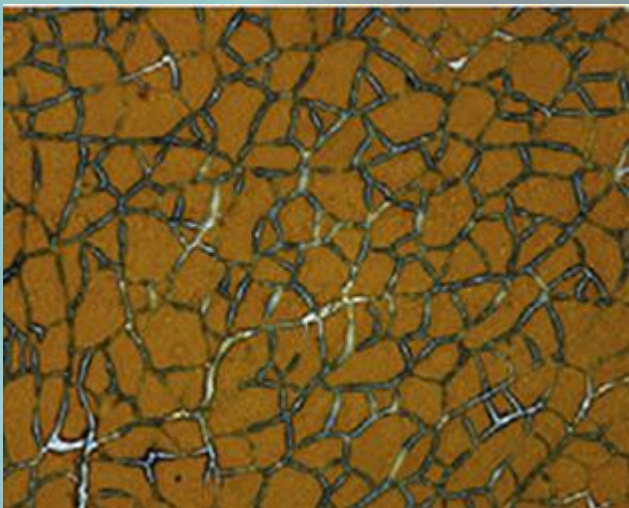


Figure 2. Texture comparison between several HPP treatments on smoked salmon. Adapted from Gudbjornsdottir *et al.* (2010).

600MPa



900MPa



0'' 20'' 60''

Changes on textural characteristics are more influenced by application time of HPP that 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-termal 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 grown at long term if no additional hurdles are applied.

EFSA. 2014. The European Union Summary Report on Trends and Sources of Zoonoses, Zoonotic Agents and Food-borne Outbreaks in 2012. *EFSA Journal*. pp:312.
McArdle, R., Marcos, B., Kerry, J.P., Mullen, A. 2010. Monitoring the effects of high pressure processing and temperature on selected beef quality attributes. *Meat Sci.* 86:629-34.
Gudbjornsdottir, B., Jonsson, A., Hafsteinsson, H., Heinz,V. 2010. Effect of high-pressure processing on Listeria spp. and on the textural and microstructural properties of cold smoked salmon, *LWT-Food Sci Technol.*43:366-374.