SENSORY AND MICROBIOLOGICAL PROPERTIES OF DRIED HAMS TREATED WITH HIGH HYDROSTATIC PRESSURE (HP)

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Background

Expansion of ready to eat (RTE) foods in the last decade has urged the need to ensure microbial safety while maintaining sensory and nutritional qualities. Among innovative mild technologies high hydrostatic processing (HP) is a promising technique for the treatment of those products that are not heat treated, such as dried hams and sausages.

Objectives

Aim of the present study was to evaluate the effect of HP treatment on the sensory and physical (instrumental colour assessment) properties of dry cured hams. The study was conducted after a preliminary investigation indicated the best conditions (pressure, time) enabling inactivation of *Listeria monocytogenes* (LM).

Materials and methods

HP equipment

HP treatments were performed by a pilot plant developed by Avure Technologies (Vasteras – Sweden). It consisted of a vertical vessel with a total capacity of 35 litres and enabling a T range of 4-90°C and max pressure of 600 MPa.

All HP treatments were performed at 600 MPa with different holding times (3, 6 and 9 minutes) at 25 °C.

Survival of Listeria monocytogenes in HP treated hams

The trials were carried out on ham slices (14 month of maturing, a_w=0.92) inoculated with *Listeria monocytogenes*, then vacuum-packed and finally treated at 600 MPa for three holding times: 3, 6 and 9 minutes (3 independent treatments). Microbial analyses were carried out at 24 hours after treatment.

1. *Inoculum preparation and inoculation procedure*

   The inoculum was prepared from a mixture of strains (Scott A and LM38, LM39, LM51 and LM134) previously isolated from meat products. The samples (N=140) were slices of dried hams (a_w= 0.92) of 25 g weight. They were partly inoculated (N= 100) at a concentration of about 10^4 cfu/g , while the remaining 40 slices were used as control. All slices were vacuum packaged for HP treatment.

2. *Microbiological analysis*

   a. *Detection of Listeria monocytogenes.* In order to determine the presence/absence of LM in 25 g of product, the ISO 11290-1 method was applied both as such and by using the ALOA (Biolife) medium (37° C for 24/48 hours) for isolation and differentiation of Listeria colonies. To quantify the contamination level (n. of Listeria/g), direct plate as count (ISO 11290-2) and/or the MPN as proposed by USDA were used. In both methods, the ALOA medium (Biolife) was used.

   b. *Total aerobic microbial count.* Triptone soy agar was used as medium (OXOID) and count was determined after incubation at 30°C for 72 hours determined.

Sensory evaluation

Descriptive attribute analysis of hams after HP treatment was conducted by a 8-member trained panel. Descriptors were rated on an intensity scale ranging 0-9. Descriptors were uniformity and intensity of colour, matured taste, salty taste, off-flavour, fibrousness on chewing, firmness.

Results and discussion

Effect of HP treatment of Listeria monocytogenes survival.

Surviving data after treatments are reported in table 1 as positive packages and surviving Listeria cells. Increasing the treatment duration (from 3 to 9 minutes) decreased viable LM cells. After 3 minutes at 600

MPa, all packages were found positive; after 6 minutes 9 out of 25 packages were positive and after 9 minutes LM was present only in one package. Results are consistent with those of other researchers who reported inactivation of fresh meat and dry-cured ham of 4-5 log cycles and 2-3 cycles respectively (1-4).
HP effects on typical microflora of dry-cured hams were also evaluated (fig.1). Microflora was reduced at all treatment times (mainly Staphylococcus strains), with 2.6, 4 and 4.5 decimal reductions after 3, 6 and 9 treatment times, respectively.
It is known that the effect of HP treatment on bacterial inactivation is influenced by several factors such as microbial morphological and structural characteristics (Gram positives more resistant than Gram negatives, cocci more resistant than rods) and physico-chemical properties of food-matrix (5). Our findings indicate that HP had more effect on LM than on typical microflora of dry-cured ham.

Sensory quality assessment of HP-treated dried hams: effects of maturing time and storage after treatment.
A trained sensory panel was asked to judge dry cured hams of different maturing age (14 and 18 months) after HP treatment. Mean scores of sensory attributes are reported in table 2, showing that colour, salty taste and firmness were mainly affected. Colour intensity decrease was less evident at 18 months, with HP treatment not significant ($P<0.05$) compared with treated samples. The matured taste did not change significantly after treatment, whereas salty taste was more intense in treated samples for both classes of age, with a marked increase in the less matured ones. Major changes in lean meat structure were also reported in terms of increased fibrousness on chewing and firmness (resistance to compression). Data indicate that sensory properties were less affected in the more aged hams, which was likely due to the relative lower impact of pressure on more dehydrated meat; this conclusion is in agreement with similar observations from other Authors working on meat substrates and other than dried hams (6).
Lighness (L*) increased after HP treatment, whereas redness (a*) decreased and yellow (b*) increased significantly (table 3). Therefore the a*/b* ratio was lower in all treated samples while the *hue* index, being inversely correlated with redness, increased. These changes were consistent with the sensory test data (table 2), suggesting that discoloration occurred as result of treatment.
In order to assess whether cold storage of HP treated hams were susceptible to change of sensory quality traits, hams were analysed at different times during one month of storage at 4°C. Results are graphically reported in fig.2 for sensory colour intensity, showing an increase of scores after 7 days of storage. It is concluded that cold storage of hams after treatment is a means to reduce the impairing effect of pressure on meat colour affecting dried hams immediately after the HP processing.

Conclusions

High hyperbaric pressure treatment allows reduction of *Listeria monocytogenes* to negligible levels in dry cured ham. Treatment affects colour (discoloration) and saltiness (enhanced perception) in such a way that changes are inversely related to the age of the ham.

References

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Table 1. Effect of HP treatment at 600 MPa on *L. monocytogenes* at inoculum level of 4.64 ± 0.58 log cfu/g.

Treatment time (minutes)	Packages treated	Packages positive after treatment (LM in 25 g)	Sample N°	Average value	Range (p=0.95)
3	25	25	14	<0.3 MPN	0.0-0.94
			11	23.2 ufc	2.6-43.8
6	25	9	9	0.47 MPN	0.0-0.97
9	50	1	1	<0.3 MPN	0.0-0.94

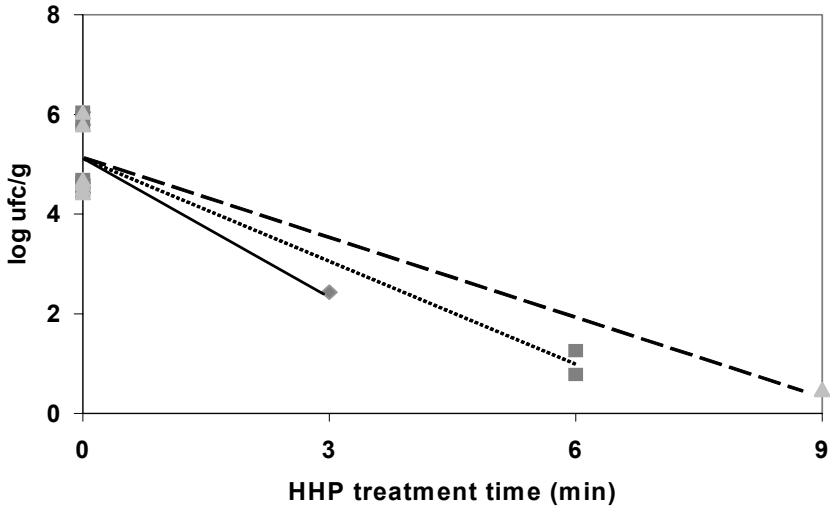

Figure 1. Total aerobic count changes after HP treatment for three different times.

Table 2. Mean scores (scale 0-9) of sensory attributes of HP-treated hams (14 and 18 months of maturing) and corresponding control samples. Means within a row with different letters differ significantly (P<0.05). Higher scores denote more intense perception of attributes.

	Dry-cured hams			
	14 months		**18 months**	
	untreated	**HP-treated**	**untreated**	**HP-treated**
Colour uniformity	6.7 [a]	6.1 [b]	6.7 [a]	6.4 [ab]
Colour intensity	6.7 [a]	5.2 [b]	6.9 [a]	6.4 [a]
Aged taste	6.3 [bc]	6.1 [c]	6.7 [a]	6.5 [ab]
Salty taste	6.0 [b]	6.9 [a]	6.3 [b]	6.8 [a]
Fibrousness	1.9 [c]	4.3 [a]	1.8 [c]	3.7 [b]
Firmness	4.6 [b]	6.3 [a]	5.1 [b]	6.6 [a]

Table 3. Instrumental colour measurements of HP-treated hams (14 and 18 months of maturing) and corresponding control samples. Means within a row with different letters differ significantly (P<0.05).

	Dry-cured hams			
	14 months aged		**18 months aged**	
	untreated	**HP treated**	**untreated**	**HP treated**
L*	42.8 [b]	46.9 [a]	41.7 [b]	45.8 [a]
a*	10.1 [a]	9.6 [b]	10.3 [a]	9.9 [ab]
b*	9.6 [b]	11.2 [a]	9.6 [b]	11.6 [a]
Chroma*	14.0 [c]	14.8 [ab]	14.1 [bc]	15.4 [a]
hue	43.3 [b]	49.5 [a]	43.2 [b]	49.4 [a]
a*/b*	1.07 [a]	0.86 [b]	1.07 [a]	0.86 [b]

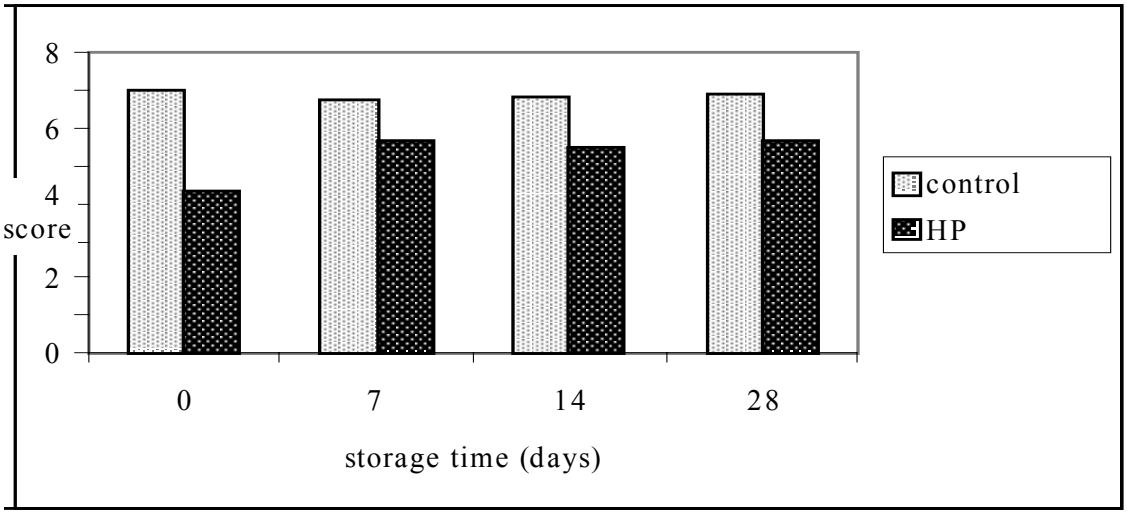

Figure 2. Sensory colour intensity of HP-treated hams and correspondig control samples at several times of cold storage.