Oxidative Stability, Vitamin B_{12} and Sensory Characteristic Changes of Pre-sliced, MAP Dry Cured Ham: Effect of Storage Conditions and Ham Ageing Time.

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Abstract— **This work was focused on studying the evolution of oxidative stability, vitamin B12, instrumental color and sensory characteristics of pre-sliced dry-cured ham in different storage conditions (combined effects of temperature and light expositions). A major aim of the study was to provide for quality indices able to describe the evolution of pre-sliced dry cured ham characteristics.**

Modified atmosphere packages (MAP) of 18- and 24-months old dry-cured Parma hams were stored in three different conditions (AFNOR International Food Standard, 2004) with combined effects of storage temperature and dark/light expositions. Gas composition, instrumental colour, moisture content, pH, aw, vitamin B_{12}, oxidative stability parameters as well as sensory analysis were carried out at five progressive steps during the storage time (1, 15, 25, 50, 65 days).

Gas composition, moisture content, pH and aw didn't show significant changes ($P>0.05$) as well as instrumental colour parameters. A weak but not significant increase of TBARS values was observed. Peroxide number showed an upward trend with significant changes after 50 days ($P<0.05$) as well as colorimetric b* index measured on outer fat layer.

Vitamin B_{12} was not affected by storage condition but a remarkable variability (CV%) was observed in less aged hams. As to sensory descriptors, several changes occurred during storage.

Storage conditions and ham ageing time affect oxidative stability, instrumental colour parameters and sensory traits of pre-sliced MAP dry cured ham. Selected sensory, chemical and instrumental parameters have been showed to be effective indicators of quality changes in pre-sliced dry-cured ham.

Keywords— **Pre-sliced dry cured ham, B_{12} vitamin, oxidative stability.**

I. INTRODUCTION

In recent years MAP pre-sliced dry cured Parma ham has been growing both on domestic and export markets, according to consumer demand of both convenience and safe, additive-free and high-nutritional value food.

Main commercial goal of pre-sliced packaging is focused on preserving nutritional, microbial and – above all – sensory characteristics of dry cured ham during the shelf-life, with particular attention to colour stability, that plays a critical role to catch consumers choice.

Recent studies evidenced that during storage several phenomena may occur, affecting the quality of pre-sliced dry cured ham: colour fading, lipid oxidation, resulting in fat yellowing and rancid odor and taste onset, are described (Parolari et al. 2009; Vestergaard et al. 1999). Furthermore, less is known on the stability of nutritional components, such as vitamin B_{12}, an important and specific nutritional component of dry-cured ham (25% RDA). Poor information is also available for biogenic amines evolution, a microbial quality indicator. (Ten Brik, 1990; Virgili et al., 2007).

This work was focused on studying the evolution of oxidative stability, vitamin B_{12}, instrumental colour and sensory characteristics of pre-sliced dry-cured ham in different storage conditions (combined effects of temperature and light expositions). A major aim of this study was to provide quality indices able to describe the evolution of pre-sliced dry cured ham characteristics.

II. MATERIALS and METHODS

Modified atmosphere packages of dry-cured Parma hams, 18- and 24-months old, were stored in three different conditions (AFNOR International Food Standard, 2004), with combined effects of storage temperature and dark/light expositions, as shown in Fig 1.

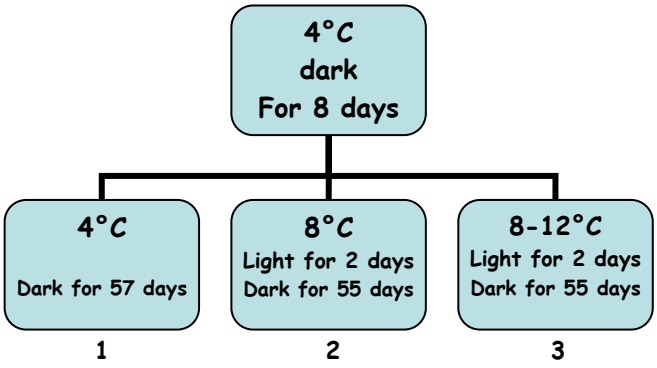

Fig.1 Experimental design: experimental conditions during the storage of pre-sliced dry cured Parma ham.

All dry-cured Parma ham packages were stored at 4°C 8 days and then divided into 3 groups, kept in different conditions (AFNOR 2004):

Shelf life 1 (4°C): 4°C for all the storage, always in the dark (controlled cold chain):;

Shelf life 2 (8°C): 8°C for all the storage, 2 days in the light and the next days in the dark (conditions at retail);

Shelf life 3 (12°C): 8°C for 14 days and 2 days in the light; next days in the dark at 12°C (insufficient control of cold chain).

Gas composition, instrumental colour (CIELab scale), moisture content, pH, a_w, vitamin B_{12}, biogenic amines, oxidative stability parameters (Peroxide number and TBARS index) as well as sensory analysis were carried out at five progressive steps during the storage (1, 15, 25, 50, 65 days).

Sensory analysis. Sensory evaluation was carried out on dry-cured Parma ham slices at each storage time by a trained 6-members sensory panel.

Descriptive sensory analyses were carried out to evaluate selected quality descriptors. Colour: visual assessment relating to the intensity of the characteristic red colour and the presence of appearance defects (colour fading, presence of white film, fat yellowing). Odour: characterstic flavour associated with the ripening process; the presence of off-flavour were evaluated. Slice separability.

Data were analysed with statistical package SPSS 11.5.

III. RESULTS

Gas composition, moisture content, pH and aw didn't show significant changes ($P > 0.05$) as well as instrumental colour parameters related to the lean part of dry-cured slices.

A weak but not significant increase of TBARS values was observed during storage.

Peroxide value showed an upward trend with significant changes at 65 days ($P<0.05$), while b* index measured on the covering fat of dry-cured ham slices, increased at 50 days of shelf-life.

Vitamin B_{12} was not affected by storage condition while a large variability (CV%) was observed depending on ham ageing time (18-months: 0,49 ± 0,15 µg/100g; 24-months: 0,66 ± 0,12 µg/100g).

Several sensory descriptors underwent changes during storage ($P<0.05$).

In tabs 1 and 2 data of the parameters that significantly changed ($P< 0.05$) over shelf-life are reported, with reference to storage time (tab.1) and storage conditions (data measured at the end of the storage) (tab.2).

The 18-months old hams are resulted more sensitive to oxidation the 24- months old ones.(Peroxide number: 18-months 4,4 ± 1,3; 24-months: 3,0 ± 1,4).

Tab 1. Mean and standard deviation values of analytical and sensory parameters that changed during the storage. Means with different letter in the same row are different (P< 0.05). (LSD test).

	Storage days			
	0	**25**	**50**	**65**
Chemical parameter				
Peroxide number	1,5 ± 0,8[a]	2,1 ± 0,5[a]	3,0 ± 1,3[b]	3,6 ± 1,5[b]
Colorimetric parameter				
b* (covering fat)	10,9 ± 1,5[a]	11,7 ± 0,9[a]	13,0 ± 1,3[b]	13,8 ± 1,9[b]
Sensory parameters				
Acceptability	6,6 ± 0,4[a]	6,4 ± 0,6[a]	6,3 ± 0,7[a]	5,5 ± 0,7[b]
Brown colour	3,9 ± 0,6[a]	4 ,0 ± 0,8[a]	4 ± 0,7[a]	4,8 ± 0,9[b]
Yellow colour (covering fat)	2,1± 0,5[a]	2,3 ± 0,5[a]	3 ± 0,4[b]	3.3 ± 0,7[b]
Slice wetness	2,8±0,5[a]	1.6 ± 0,8[b]	2,2 ± 0,5[a,b]	2,7 ± 1,4[a]
Rancidity off-flavour	1,5 ± 0,5[a]	1,7 ± 0,4[a]	1,7 ± 0,6[a]	2,4 ± 0,8[b]
Matured ham flavour	6,8 ± 0,5[a]	6,3 ± 0,7[a]	6,2 ± 0,7[a]	5,7 ± 0,7[b]
Slice separability	6,8 ± 0,9[a]	6,6 ± 0,9[a]	6,7 ± 0,9[a]	5 ± 1,5[b]

	Shelf life 1	**Shelf life 2**	**Shelf life 3**
Chemical parameter			
Peroxide number	2,4 ± 0,9[a]	3,8 ± 1,1[ab]	4,9 ± 1,5[b]
Colorimetric parameter			
b* (covering fat)	12,6 ± 1,0[a,]	12,1 ± 1,2[a]	13,8 ± 1,1[b]
Sensory parameters			
Acceptability	6,1 ± 0,7[a]	5,5 ± 0,9[a]	4,6 ± 0,7[b]
Brown colour	3,6 ± 0,6[a]	4,1 ± 0,8[a]	4,9 ± 1,0[b]
Yellow colour (covering fat)	2,6 ± 0,7 [a]	2,9 ± 0,6 [a]	3,9 ± 0,9 [b]
Slice wetness	2,0 ± 0,5 [a]	2,0 ± 1,2 [a]	4,0 ± 1,5 [b]
Rancidity off-flavour	1,9 ± 0,3[a,]	1,9 ± 0,8[a]	2,8 ± 0,7[b]
Slice separability	6,5 ± 0,9 [a]	6,6 ± 1,3 [a]	5,4 ± 1,1 [b]

Tab. 2 Mean and standard deviation values of analytical and sensory parameters affected by storage conditions at 65 days of storage. Means with different letter in the same row are different (P< 0.05). (LSD test).

CIE Lab parameters of the lean part are not subjected to significant change during storage time; a* and C* indices showed the highest value in shelf-life 1, corresponding to the continuous control of reference temperature and darkness (data not reported). Vitamin B_{12} is affected neither by storage time nor by storage condition, as well as biogenic amines (data not reported).

Sensory parameters reported in tab. 1 were affected by storage time ($P < 0.05$), showing a change at the last tested deadline (65 days). Most of reported sensory descriptors resulted impaired by shelf-life 3 condition (protracted storage at abuse temperature) as shown in tab.2.

IV. DISCUSSION

Storage duration and conditions affect oxidative stability, instrumental colour and sensory traits of pre-sliced dry cured ham. Sensory descriptors “Brown colour of lean”, “yellow colour of covering fat”, “Rancid odour”, “Matured ham flavour”, “Slice separability” are effective markers of sensory shelf-life. Chemical and colour parameters related to oxidation like peroxide number and b*index on fat can support changes perceived from the sensory point of view. The nutritional value of the product is not affected by storage condition, confirming pre-sliced dry-cured Parma ham as an excellent source of B-group vitamins. Biogenic amines are also stable excluding a positive decarbossilase microflora growth during storage and confirming the data obtained in previous studies (4).

V. CONCLUSIONS

This study allows to evidence several specific analitycal and sensory indices suitable to describe the evolution of quality of MAP pre-sliced dry cured Parma ham during the storage shelf-life.

Peroxide number, CIELab b* index of coveringe fat, variation in sensory scores of brown colour, slice separability, yellow colour of covering fat, as well as matured ham flavour and rancidity off-flavour, can monitor the evolution of the overall acceptability of modified atmosphere pre-sliced ham, in relation to the duration and the conditions of shelf-life.

Sensory and chemical-physical changes are related both to lean and fat fraction of dry-cured ham, while B_{12} content resulted as not affected during shelf-life, even if inadequate temperature conditions occurred. The stability of biogenic amines let to exclude a positive-decarboxylase microflora growth after packaging and during the cold storage.

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