EVALUATION OF MEAT QUALITY IN FRESH AND FROZEN HAMS

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Background
Development of probes for categorising raw meat, soon after slaughter and in factories, is necessary due to the growing interest in meat quality, in order to select the most appropriate use for different meat products and to obtain a final product with exceptional sensory characteristics. In this sense, meat of a pale, soft and exudative nature (PSE) is a serious problem in the industry and raw PSE hams used to lead to defective texture products. Some of the main problems on texture in this case, over all in cooked ham and dry-cured ham, are the pasty texture, the inconsistently texture or the heterogeneous texture. Unsuitable texture could be due to different evolution of PSE hams throughout aging. Previous studies have showed that the weight losses, denaturation, proteolysis and NaCl concentration are higher in PSE than in normal hams (Arnau *et al*, 1995). The measurements of pH and electrical conductivity (EC) at 2 h post-mortem are methods to classify PSE meats (Garrido *et al*, 1994, Whitman *et al*, 1996). Colour evaluation would be another alternative, since PSE meats are different in this sense, but results found by different researchers do not agree (Chizzolini *et al,* 1993). However, few of the previous studies evaluated the PSE raw material in the industry, where fresh or frozen hams are received to be processed.

Objectives
The aim of this study is to evaluate instrumental methods (pH, EC, colour) as predictors of PSE meat after slaughter and in the factory, after frozen meat is received and defrost to be processed.

Methods
75 normal and 125 PSE raw hams weighing between 9 - 13 Kg were classified according to their pH at 2h post-mortem in *Semimembranosus* (SM) muscle (normal pH= 6-6,2, PSE pH < 5,8). Besides, electrical conductivity (EC) with Pork Quality Meter and colour measurements (L*, a*, b* values and % brilliance- %Z) using a spectrocolorimeter (Hunterlab) were evaluated at 2 h post-mortem in SM muscle in all hams selected. Hams were excised from carcasses and frozen, sent to the factory and defrozen there in 48 h. In defrost hams at 4- 5ºC, the same measurements that in the slaughterhouse were done. SM and Biceps *femoris* (BF) muscles, representative of the two main different zones usually present in dry cured ham, were removed from 20 normal and 20 PSE representative hams and analysed in order to confirm the physicochemical characteristics of the both types of hams.
The following analysis were carried out: cathepsin B activity (Parolari *et al,* 1994), moisture content calculated measuring weight loss at 103 ºC $\pm$ 2ºC to constant weight, water activity (aw), total nitrogen by the Kjeldhal method and fat content by Soxleht method. Nitrogen fractions (non-protein nitrogen or NPN, myofibrilar protein, sarcoplasmic protein, denaturated protein and stroma) were determined (Astiasarán *et al,* 1988). SDS-PAGE (12%) was performed to examine the proteolytic changes of myofibrilar proteins in the PSE and normal samples (Claeys *et al,* 1995).

Results and discussion

1. Instrumental methods as predictors of pork meat quality
Main values of instrumental data for normal and PSE raw hams, at 2 h post-mortem and after defrost, are shown in Table 1.

Results indicate pH, EC, L* and b* at 2 h post-mortem differ significantly between normal and PSE meat ($\alpha = 0.01$), in agreement with other authors (Garrido *et al,* 1994) and as %Z. However, as was expected, after defrost of meat in factory, measurement of pH and EC do not permit the differentiation between normal and PSE meat. However, results show there is a significant difference respect L*, b* and %Z values between normal and PSE hams. The measurement of *a** is not useful to classify normal and PSE meat in any case.

Correlation between the different quality characteristics was studied. Results show there is a significant relationship between pH and EC at 2h post-mortem ($r = 0.873$). Colour parameters L* and b* at 2h are also significantly correlated with pH 2h ($r = -0.515$ and $r = -0.645$ respectively). On the other hand, after defrost in factory, a significant relationship between L*, b*, %Z and pH 2h and EC 2h ($r > 0.55$) is found, being L* and %Z significantly correlated between them. In this sense, the measurement of colour parameters, after frozen and defrost, would be allow to classify correctly PSE and normal meat in factory, with a fast and no destructive method.

A principal components analysis (PCA) and discriminate analysis considering all these parameters (pH, CE and colour at 2 h and in factory) has been carried out, in order to determine if a correct classification of raw meat is allowed. Figure 1 shows how the different samples are positioned in the plane determined by the first two principal components, being a clear differentiation between PSE and normal raw hams.

Discriminant analysis considering pH, CE, L*, b* and %Z at 2 h show a correct classification of 97.2% for normal hams and 96.5% for PSE hams. L*, b* and %Z measurement in factory classify correctly a 93.8% of normal hams and a 91.3% of PSE hams, confirming the measurement of colour parameters L*, b* and %Z would be useful to classify PSE meat in factories, after defrost.

2. Composition of PSE and normal raw hams

Analysis of raw material showed significant differences between PSE and normal hams for water activity, moisture, enzymatic activity and denatured protein fraction.

According to results, there is significant difference in moisture and water activity between PSE and normal hams in SM muscle ($P<0.05$), being moisture and water activity higher in normal hams in this muscle. However, in BF muscle, the moisture did not differ significantly between PSE and normal hams. In its turn, PSE hams showed a higher denaturated protein fraction than normal hams in SM muscle ($P<0.05$), probably due to the lost of moisture. These results could explain the posterior superficial hardness that is usual in PSE hams and the higher weight losses in PSE hams (Arnau *et al*, 1995).

On the other hand, about cathepsin B activity a significant higher value for PSE hams was found. These results indicate a posterior higher proteolysis level in PSE hams, in agreement with the results of Sárraga *et al* (1993). SDS-PAGE results make evident that there were not important differences in the proteolytic pattern of myofibrilar proteins between raw PSE and normal samples. The rest of physicochemical parameters analysed did not differ significantly between PSE and normal hams.

PSE hams show lower moisture content and water activity in SM muscle than normal hams, a higher denaturation of proteins and a higher level of cathepsin B. Subsequently, these properties of PSE hams will lead to unsuitable final sensory characteristics, if they are processed in the same way that normal hams. If PSE raw meat could be correctly detected and classified in the factory, for example by colour, it would be possible to modify the process or to find a different use for this meat in order to avoid defective final textures.

Conclusions

pH, EC and measurement of colour parameters L*, b* and %Z at 2 h post-mortem in SM muscle are appropriate predictor methods of pork meat quality, being all theses parameters correlated between them. Measurement of colour parameters L* and b* in factory, after hams have been frozen and defrost, would be a good method to classify correctly PSE hams.

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Table 1. Values of instrumental data for normal and PSE raw hams

		NORMAL		PSE	
		MEAN	σ	MEAN	σ
at 2h postmortem	pH	6.26 ^{b}	0.30	5.63 ^{a}	0.18
	EC	4.93 ^{a}	0.90	11.63 ^{b}	2.61
	L*	36.94 ^{a}	5.34	46.36 ^{b}	9.61
	a*	8.91 ^{a}	3.33	7.27 ^{a}	4.64
	b*	13.93 ^{b}	1.15	11.85 ^{a}	3.39
	%Z	6.79 ^{a}	3.24	13.82 ^{b}	6.51
after defrost	pH	5.72 ^{a}	0.17	5.52 ^{a}	0.06
	EC	18.14 ^{a}	9.25	17.39 ^{a}	1.12
	L*	46.34 ^{a}	9.25	52.69 ^{b}	6.64
	a*	11.7 ^{a}	4.25	10.81 ^{a}	3.17
	b*	14.49 ^{a}	4.07	16.38 ^{b}	5.01
	%Z	11.43 ^{a}	5.31	14.18 ^{b}	5.01

In a file, meanswith different superscripts are significantly different ($\alpha= 0.01$)

Figure 1. Principal Component Analysis (PCA). Plot of the first two principal components score vectors. Location of samples in the plane.