SPECTROSCOPIC TECHNIQUES FOR QUALITY EVALUATION OF DRY-CURED PARMA HAM

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Background

The dry-curing process used for ham results in substantial physical and chemical changes of the meat during the lengthy process[1]. Several studies have investigated changes in both the lipid and protein fraction during the processing of dry-cured ham[2,3]. In dried Parma hams inconsistent quality traits may sometimes occur and efforts are being made to mark defective products at early stages, in order to help manufacturers reduce economic losses. In this context, new and innovative methods for evaluation of Parma ham quality during processing can be useful, and rapid and objective techniques such as NIR and fluorescence spectroscopy have proven useful for prediction of properties in raw meat[4,5].

Objectives

The objective of the present study was to assess the potential of using spectroscopic techniques in combination with multivariate data analysis as a mean of predicting chemical or visual sensory parameters related to quality or maturation of dry-cured Parma ham during processing.

Methods

Ham samples were taken from two muscle, i.e. *semi membranosus* (SM) and *biceps femoris* (BF), and ranged from salted (3 month) to matured (11 and 12 months) and further to aged (15 and 18 months) Parma hams. The samples were analysed by visible/near infrared (VIS/NIR) and autofluorescence spectroscopy. VIS/NIR spectra collected using a NIR Systems Inc. (Silver Spring, MD, USA) model 6500 spectrophotometer measuring reflectance between 400-2500 nm. Fluorescence spectroscopy was measured with a BioView systems instrument (Delta Light & Optics, Lyngby, DK). Fluorescence spectra were measured using 15 excitation and emission filters, respectively, with excitation from 270 to 550 nm and emission spectra from 310 to 590 nm both at 20 nm intervals. Instrumental colour of freshly cut muscles was quantified in terms of CIE L*, a*, b*, hue and chroma by a Minolta d-508 spectrocolorimeter. Visual colour assessment (colour1) of the same samples was performed by an expert panel rating redness intensity on a nine-point scale with extremes (0-9) corresponding to absence and extreme redness perception, respectively. Proximate composition data were measured according to AOAC standards and a proteolysis value was determined on BF muscle as non-protein nitrogen by trichloroacetic acid treatment. Spectral data from NIR were transformed by multiplicative scatter correction (MSC) and duplicate fluorescence spectra were averaged for each sample. Then spectral and chemical/visual data were analysed by multivariate partial least squares (PLS) regression methods in Unscrambler ver. 7.6, whereas NIR data subsequent was submitted to interval PLS (iPLS) regression using an algorithm in MatLab ver. 6.2 [6].

Results and discussion

In general, NIR spectral data was found to correlate poorly both with chemical and visual parameters, and this may be due to a relative high degree of variation within samples from similar processing stages. Moisture content, a parameter, which can be normally predicted by NIR in a variety of foods, displays low correlation if all hams are analysed at the same time, while correlation is improved if samples from the same muscle type are considered independently. The same occurs with visual colour1, showing better relationship to NIR data, when selected variable intervals are used, which suggests that more in-depth analysis of spectral data is needed for NIR spectroscopy to be used in predictive models.

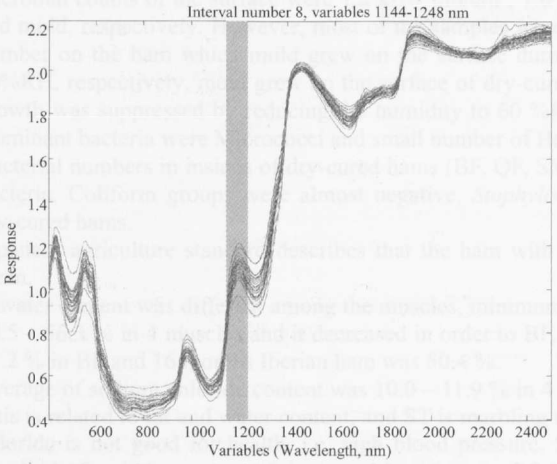

Figure 1. NIR spectra (MSC) from 35 Parma ham samples at various stages of processing. Bar shows variable interval no. 8 used in iPLS regression for visual parameter, colour1.

Table 1. Results from PLS regression of NIR spectra versus chemical and visual parameters. PLS regression analysis was performed on subsets of samples either using all variables (400-2500 nm) or an optimal interval of variables identified by iPLS regression.

Regression Parameter	Samples				
	All (*n*=35)	*Semi membranosus*		*Biceps femoris*	
		All (n=18)	11-18 months (n=15)	All (n=17)	11-18 months (n=15)
Moisture *(PLS1)*	r=0.495	r=0.805	r=0.087	r=0.808	r=-0.151
Colour 1 *(PLS1)*	r=0.704	r=0.715	r=0.513	r=0.764	r=-0.063
Interval PLS (1144-1248 nm)	r=0.787	-	-	-	-
a* value *(PLS1)*	r=0.587	r=0.490	r=0.147	R=0.513	r=0.797
Interval PLS (1452-1660 nm)	r=0.617	-	-	-	-

Fluorescence spectra seem to contain much more relevant information regarding processing stage and chemical components of Parma ham. Here only results originating from BF are presented as this muscle exhibits more consistent results and in general better correlation. Moreover, it is even possible to predict chemical parameters using only maturing samples from 11 to 18 months. This group of samples is by far the most interesting, and regression between salted and maturing Parma ham may produce artistically high correlation coefficients as regression line is made between two distinct groups of samples. Each plot in Figure 2-4 shows results of calibration and validation (two lines) for

measured versus predicted values and full cross-validated regression variables including relative mean squared error of prediction (RMSEP) for Parma ham samples (BF) based on fluorescence data. In some cases a reduction in RMSEP is observed for PLS regression only with maturing samples.

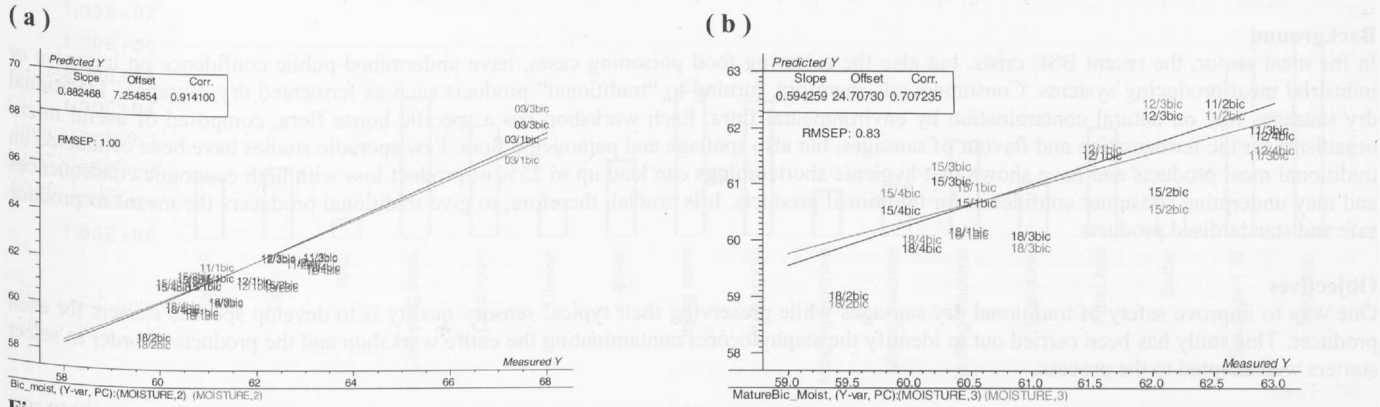

Figure 2. PLS regression of fluorescence spectra and moisture content of *biceps femoris* from Parma ham including samples from 3 month to 18 months (plot a, n=17) or only maturing samples from 11 months to 18 months (plot b, n=15)

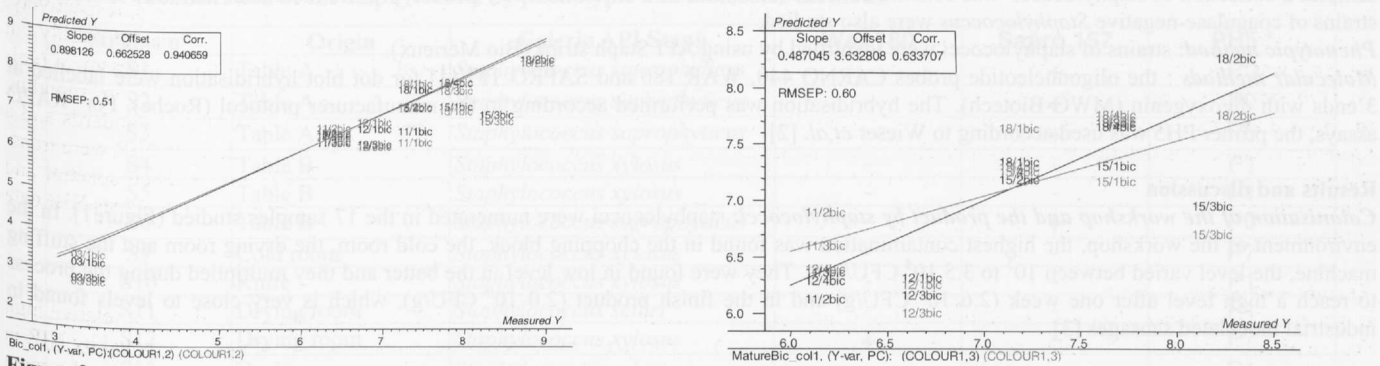

Figure 3. PLS regression of fluorescence spectra and visual colour1 of *biceps femoris* from Parma ham including samples from 3 month to 18 months (plot c, n=17) or only maturing samples from 11 months to 18 months (plot d, n=15)

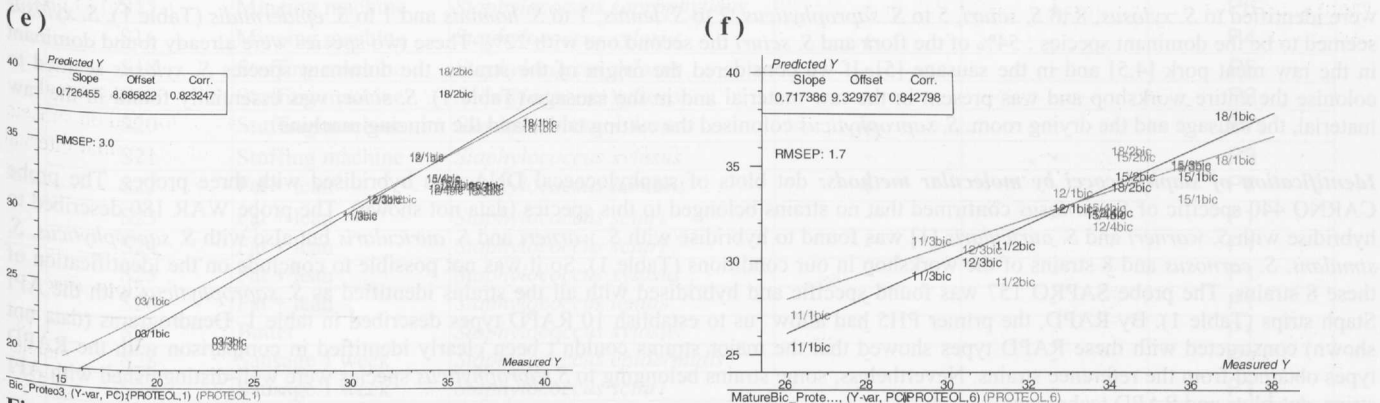

Figure 4. PLS regression of fluorescence spectra and proteolysis in *biceps femoris* from Parma ham including samples from 3 month to 18 months (plot e, n=15) or only maturing samples from 11 months to 18 months (plot f, n=13)

Conclusion

NIR spectral data is poorly correlated to chemical/visual properties of Parma ham at different stages of processing, which may be due to high variation within samples from the same stage. On the other hand, fluorescence spectra hold information that enables the separation of Parma ham samples based on their processing stage, and in addition satisfactory correlation can be observed between chemical/visual properties and fluorescence spectra, even when only maturing samples are analysed. Future work should further investigate the ability of fluorescence spectroscopy as a method for evaluating Parma ham quality and predict undesired properties.

Pertinent literature

1. Flores, J. (1997). *Food Chemistry* **59**:505-510
2. Vestergaard, C.S., Schivazappa, C.,Virgili, R. (2000). *Meat Science* **55**:1-5
3. Virgili, R., Parolari, G., Bordini, C.S.,Schivazappa, C. (1999). *Journal of Muscle Foods* **10**:119-130
4. Forrest, J.C., Morgan, M.T., Borggaard, C., Rasmussen, A.J.,Jespersen, B.L. (2000). *Meat Science* **55**:115-122
5. Egelandsdal, B., Wold, J.P., Sponnich, A., Neegard, S.,Hildrum, K.I. (2002). *Meat Science* **60**:187-202
6. Norgaard, L., Saudland, A., Wagner, J., Nielsen. J.P., Munck, L.,Engelsen, S.B. (2000). *Applied Spectroscopy* **54**:413-419