NIR AND VIS-NIR SPECTROSCOPY TO PREDICT PSE-LIKE ZONES OF HAM

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Abstract – The aim of the study was to evaluate NitFom´s ability to predict PSE-like zones, a muscle structure defect in ham, which at present can only be detected by visual inspection after deboning. NitFom is an on-line fast device based on NIR spectroscopy dedicated to the meat industry. In comparison with the Vis-NIR Labspec4 spectrometer, the overall misclassification level of the NitFom is higher (13.0% vs 26.1%). However, misclassification of deboned ham deeply affected by PSE-like zones is lower for both devices (25% of false positives for NitFom). This level of accuracy could be satisfactory and useful for the meat industry, considering that the use of NitFom allow sorting of bone-in hams. The NitFom accuracy for PSE-like zone classification might be improved by expanding the range of spectrum analyzed by adding the visible wavelengths.

Key Words – pork, meat quality, NIR spectroscopy, on line prediction.

I. INTRODUCTION

PSE-like zones are still a major concern for the meat processing industry. This structure defect of the ham is known to increase slicing losses of the phosphate-free "Jambon Cuit Supérieur" processing. PSE-like zones are difficult to detect before deboning due to their localization on the inside surface of the ham, even in severe stages of destructuration (class 3 and 4). Several studies focusing on prediction of the defect revealed that determination of classical meat quality parameters (early post mortem pH, ultimate pH, meat color) in bone-in hams were not accurate enough. Near Infra-Red Spectroscopy (NIRS) devices such as Labspec4 and vision based systems can be considered as alternative techniques to human subjective grading [2][3], but measurements must be conducted on deboned hams. The NitFom (Frontmatec) is a NIR based measuring device initially dedicated to the prediction of iodine value and fatty acid profile of pork subcutaneous fat. It performs on-line measurements at high speed on hot or cold carcasses by invasive probing. The objective of the study was to evaluate the accuracy of PSE-like zone classification using NitFom on bone-in hams and to compare its prediction quality with the previously tested Labspec4 on deboned hams.

II. MATERIALS AND METHODS

A population of 146 hams was randomly selected at 24h post mortem from standard production batches (Piétrain sire). NIR spectra were collected with the NitFom (995-2200nm) on the *Semimembranosus* muscle of bone-in hams. A subpopulation of 46 hams was selected by ultimate pH level to obtain a uniform pH distribution [4]. After deboning, Vis-NIR spectra were measured on the subpopulation with a Labspec4 spectrometer (ASDI, 350-2500nm) on the internal surface of the *Semimembranosus* muscle. The 146 hams were deboned and classified by subjective evaluation into 4 classes using the IFIP scale (1: no defect; 2: slight defect; 3: deep defect located on the topside; 4: deep defect located on the topside and silverside)[1]. Spectral data were treated with Matlab software (Version R2010a) and Eigenvector toolbox (Version 8.0.1). Spectra were preprocessed using normalization to water peak and auto-scaling for NitFom, and using auto-scaling for Labspec4. NIRS or Vis-NIRS classification of PSE-like zones were conducted by PLSDA.

III. RESULTS AND DISCUSSION

The randomly selected data set (n=146) showed a 17% rate of PSE-like zones, which is similar to the defect frequency in previous studies based on random selection (table 1). The higher rate of defect (26%) for the subpopulation (n=46) is the result of the uniform distribution of the ultimate pH. The increase in low ultimate pH is well known to induce a higher risk of PSE-like zones.

Table 1: Reference data set for PSE-like zones classification

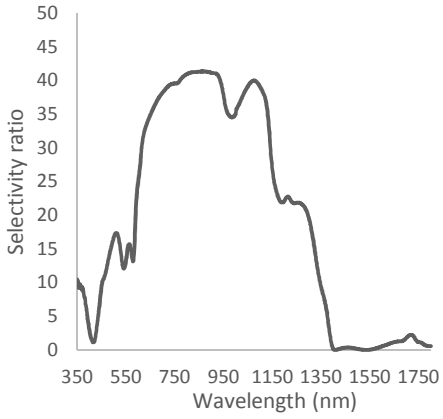
		Sample selection	PSE-like zones subjective classification		
			1	2	3+4
NitFom	(n=146)	random	85	36	25
Labspec4	(n=46)	uniform pH24 distribution	21	13	12

Classification into absence or presence of PSE-like zones (class 1+2 vs 3+4) in the 46 bone-out hams, revealed an overall misclassification of 26% by NitFom (table 2). The Labspec4 spectrometer accuracy was higher (13% of misclassification) confirming previous results [2]. The NitFom misclassification ratio for class 3+4 (false positives) is also higher than Labspec4 (25% vs 8.3%). Table 2 shows that, applying a 3 grade classification of PSE-like zones does not modify Labspec4 accuracy, but it increases the overall misclassification ratio of NitFom. In the 146 bone-in hams (table 1) the NitFom misclassified 31.5% of the population (data not shown). The higher number of misclassified bone-out hams by the NitFom may be explained by the range of wavelength collected by the devices: NIR only for the NitFom and visible+NIR for the Labspec4. As presented in figure 1, the weight of the visible spectrum (380-780nm) in the PLSDA calibration is important. An important point is that the measurement location differs between the two devices. Labspec4 is placed on a wide zone of the internal surface of the *Semimembranosus* whereas the NitFom penetrates 3 cm into the tissue depth.

Table 2: NitFom and Labspec4 cross validation results for PLSDA classification of PSE-like zones

Device	Observed PSE-like zone grading	PLSDA prediction			Overall misclassification
		1+2		3+4	
NitFom (n=46)	1+2	25		9	26.1%
	3+4	3		9	
LabSpec4 (n=46)	1+2	29		5	13.0%
	3+4	1		11	
		1	2	3+4	
NitFom (n=46)	1	16	4	2	30.4%
	2	2	8	2	
	3+4	2	2	8	
LabSpec4 (n=46)	1	21	0	0	13.0%
	2	2	7	4	
	3+4	0	0	12	

Figure 1: Labspec4 selectivity ratio for class 1+2 vs 3+4 discrimination



IV. CONCLUSION

This study confirmed that PSE-like zones could be detected with NIR spectroscopy in hams. Labspec4 includes the visible spectrum (Vis-NIR) and are found to be more accurate on bone-out hams at-line, but the on-line NitFom (NIRS only) precision to detect deep PSE-like zone stages (class 3+4) could be a useful sorting tool for bone-in hams. Expanding the spectral range in the NitFom by including the visible region might improve its accuracy.

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