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

A. Vautier[1*], T. Pieper[2], T. Lhommeau[1], H. Petersen[2] and M. Christensen[2]

[1]IFIP – Institut du Porc, La Motte au Vicomte, BP 35104, 35651 Le Rheu Cedex, France.

[2]FRONTMATEC, Hassellunden 9, 2765 Smørum, Denmark.

*Corresponding author email: antoine.vautier@ifip.asso.fr

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	1+2	25	9		26.1%
(n=46)	3+4	3	9		
LabSpec4	1+2	29	5		13.0%
(n=46)	3+4	1	11		
		1	2	3+4	
NitFom	1	16	4	2	
(n=46)	2	2	8	2	30.4%
	3+4	2	2	8	
LabSpec4	1	21	0	0	
(n=46)	2	2	7	4	13.0%
	3+4	0	0	12	

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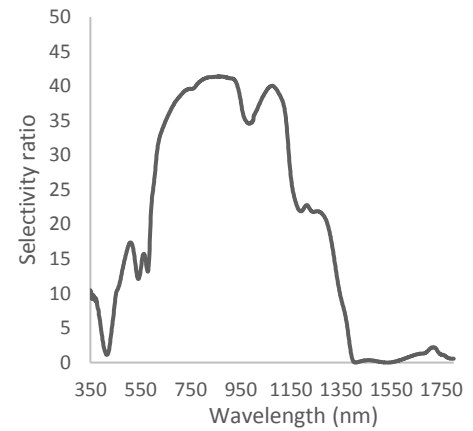
IV. CONCLUSION

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.

REFERENCES

1. IFIP. 2005. Grille de notation du défaut "déstructuré" des muscles de la cuisse de porc. 4p.
2. A. Vautier, T.Lhommeau, G. Daumas. 2013. A feasability study for the prediction of the technological quality of ham with NIR spectroscopy. 64th annual meeting of the European federation of animal science, Nantes, France.
3. A. Vautier, M. Monziols, T. Lhommeau, E.Gault. 2016. Prediction of PSE-like zones, ultimate pH and cooking yield by computer image analysis of deboned hams. 62nd International Congress of Meat Science and Technology, Bangkok, Thailand.
4. A. Vautier, T.Pieper, T. Lhommeau, M. Christensen. 2017. Prediction of drip loss and ultimate pH in pork *Semimembranosus* by the NitFom: a NIR spectrometer dedicated to the meat industry. 63rd International Congress of Meat Science and Technology, Cork, Ireland.