Hyperspectral Imaging of deboned hams: determination of relevant areas for the prediction of water holding capacity

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Introduction: The potential of NIRS (Near InfraRed Spectrometry) to predict the water holding capacity of meat has been studied for years. The major constraint of the development of NIRS in the industry comes from the contact needed between the probe and the meat. This work is focused on testing hyperspectral imaging as a contactless alternative of NIRS.

Materials and methods: A population of 81 fresh pork hams were selected according to the Semimembranosus ultimate pH (<5,6: n=18 / 5,6-5,8: n=38 / 5,8-6,0: n= 18 />6,0: n=7). After deboning, hyperspectral images were recorded using 2 cameras (Fx10 and Fx17, Specim, Finland) mounted together on a lighting system previously developed for visionic applications (Vautier et al., 2016). We added halogen lamps and a conveyor (Couëdic-Madoré, France) to fit the linear cameras requirements (belt speed= 0,15 m/sec.). Hyperspectral images were obtained by merging data from both cameras, showing a spectral range from 350 nm to 1700 nm. Reference meat quality parameters were measured on Semimembranosus (ultimate pH, 24h p.m.), Gluteus Medius (EZ drip loss sampling, Rasmussen et al., 1996) or on the entire deboned ham (subjective "PSE-like" zone grading, IFIP 2005). Individual cooked ham processing was performed by Fleury Michon (Pouzauges, France) and the cooking and slicing yields were recorded (Vautier et al., 2011). Spectral data sets were built by averaging the pixels spectra from selected muscle areas (entire deboned ham, entire topside, center of the topside, peripheral area of the topside, entire Gluteus Medius). PLS models were determined by random cross validation using Matlab 7.10.0 software (Natick, USA) and Eigenvector toolbox (Manson, USA).

Results: For most of the meat quality parameters, we obtained the best accuracy with average spectra from entire topside images. This is in agreement with previous studies were the Semimembranosus muscle was considered as the best area for the prediction of the cooking yield of ham using ultimate pH (Gueblez et al., 1990). The determination coefficients of cross validation indicate well fitted models for the prediction of ultimate pH and cooking yield (R^2_{cv}=0,66 and 0,65; respectively) confirming results obtained previously with NIRS probes (Vautier et al., 2013 and 2017). The drip loss of Gluteus Medius is surprisingly better predicted with spectra from topside than from Gluteus Medius (R^2_{cv}=0,36 vs 0,28; respectively). Logically, PSE-like zone defect classification models show better results with data sets from the Semimembranosus center (R^2_{cv}=0,28; classification error=3,8%), knowing that this area is the most affected by the defect. Models developed for the prediction of slicing defects show promising results (R^2_{cv}= 0,35 to 0,50).

Conclusion: Hyperspectral imaging associated with a closed lighting system looks very promising. For the prediction of the water holding capacity, the accuracy level is found to be as precise as the NIRS. Considering the representativeness of the spectrum obtained, hyperspectral imaging is definitely a more powerful tool than NIRS. And its best advantage is certainly the contactless measurement allowing prediction in motion.

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Literature:

- Gueblez R., Le Maitre C., Jacquet B., Zert P. 1990. Nouvelles équations de prédiction du rendement technologique de la fabrication du Jambon de Paris. Journées de la Recherche Porcine en France, 22, 89-96.
- IFIP. 2005. Grille de notation du défaut « déstructuré » des muscles de la cuisse de porc.
- Rasmussen, A. J., & Andersson, M. 1996. New method for determination of drip loss in pork muscles. 42nd international congress of meat science and technology, Lillehammer, Norway.
- Vautier A., Bozec A., Gault E., Lhommeau T., Martin J.L., Vendeuvre J.L. 2011. Visible spectroscopy and redox potential as alternatives of ultimate pH for cooking yield prediction. 57th international congress of meat science and technology, Ghent, Belgium.
- Vautier A., Lhommeau T., Daumas G. 2013. A feasibility 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.
- Vautier A., Monziols M., Lhommeau T., Gault E. 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.
- Vautier A., Pieper T., Lhommeau T., Petersen H., M. Christensen. 2017. Prediction of drip loss and ultimate pH in pork semimembranosus by the Nitfom. 63rd International Congress of Meat Science and Technology, Cork, Ireland.