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Data fusion of hyperspectral images for the prediction of bacterial growth on beef *Longissimus dorsi m.* under simulated normal and abuse storage conditions (#511)

Eva M. Achata[1], Marcia Oliveira[2], Carlos Esquerre[1], Brijesh K. Tiwari[2], Colm O'Donnell[1]

[1] University College Dublin, School of Biosystems and Food Engineering, Dublin, Ireland; [2] Teagasc Food Research Centre, Food Chemistry and Technology, Dublin, Ireland

Introduction

The *Longissimus dorsi m.* of beef is highly valued by consumers and is normally aged to increase tenderness, juiciness and flavour. However the microbial load may increase during aging with associated risks for meat safety and shelf life. Traditional techniques to monitor microbial load are time consuming, require sample preparation and interpretation of results. Hyperspectral imaging (HSI) coupled with chemometrics is a promising non-destructive and rapid technique for food analysis and food safety evaluation which may be employed for microbial growth monitoring. The objective of this study was to evaluate the potential of data fusion of visible-short wave near infrared (V-SWNIR) and near infrared (NIR) hyperspectral images and chemometrics to predict bacterial growth on beef *longissimus dorsi m.* under simulated normal and abuse storage conditions.

Methods

A total of 104 samples of the *Longissimus dorsi m.* from 9 cattle were stored at 4 ºC (n=53) for two weeks and at 10 ºC (n=51) for one week. During storage period, samples were scanned in the V-SWNIR-HSI (400-1000 nm) and the NIR-HSI (880-1720 nm) spectral range. The total viable count of bacteria (TVC) of all samples was determined using the standard methodology ISO 48833-1:2013. PLS-R, low level data fusion, spectral pre-treatments and the enhanced Monte Carlo variable selection method (EMCVS) were used to predict TVC values with the HSI data obtained.

Results

The best prediction model (R^2_p=0.86, RPDp=2.58, RMSEp=0.94) was obtained using the EMCVS and SNV + SD spectral pre-treatments on the Vis-NIR reflectance spectra. TVC predicted versus actual values are presented in Figure 1. Spectral differences between samples at day 0 from stored samples over the spectral range 630 to 700 nm may be related to the oxidation of myoglobin pigments due to microbial growth and proteolytic changes during storage.

Conclusion

The TVC values on *Longissimus dorsi m.* under simulated normal and abuse storage conditions were predicted adequately using low level data fusion of V-SWNIR and NIR HSI systems. This study demonstrates the potential of Vis-NIR hyperspectral imaging and chemometrics as a rapid tool for the prediction of microbial growth on meat during storage.

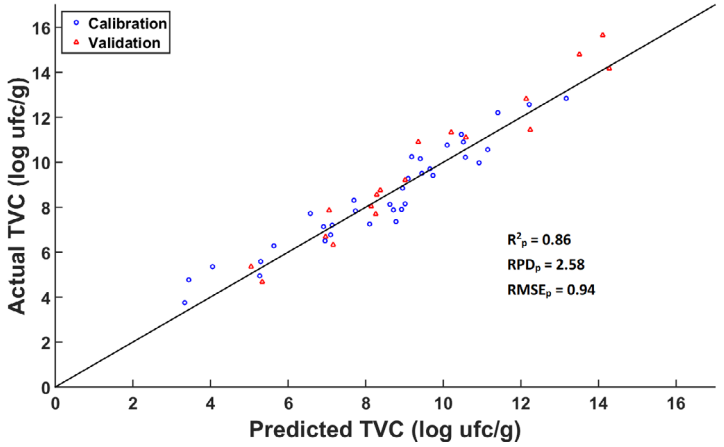

Figure 1
Predicted vs Actual TVC values obtained using the EMCVS + SNV + SD on the 400 -1720 nm spectral range.

Notes

Table 1. Fenalår characteristics through the elaboration process

Product | Days of processing	Weight loss (%) Mean	desvest	pH mean	desvest	Min	max	a_w mean	desvest	Min	max
SS										
44 days[a]	1.83	0.52	5.69	0.07	5.63	5.92	0.958	0.004	0.951	0.966
54 days[b]	20.11	1.72	5.62	0.04	5.53	5.68	0.944	0.009	0.920	0.956
67 days[c]	27.75	0.80	5.53	0.05	5.44	5.62	0.932	0.008	0.919	0.943
74 days[d]	35.11	1.28	5.48	0.06	5.42	5.63	0.914	0.013	0.896	0.932
90 days[e]	38.19	0.31	5.56	0.02	5.53	5.61	0.909	0.008	0.891	0.918
SR										
44 days[a]	1.63	0.00	5.65	0.03	5.62	5.70	0.967	0.005	0.960	0.974
54 days[b]	22.93	0.34	5.64	0.03	5.56	5.68	0.949	0.008	0.934	0.960
67 days[c]	29.53	0.00	5.56	0.06	5.48	5.61	0.931	0.012	0.912	0.943
74 days[d]	30.89	2.95	5.49	0.06	5.39	5.63	0.933	0.006	0.925	0.943
90 days[e]	40.82	0.00	5.66	0.03	5.63	5.70	0.917	0.010	0.901	0.927
NNSR										
44 days[a]	1.49	0.28	5.65	0.04	5.60	5.72	0.963	0.004	0.954	0.967
54 days[b]	20.00	0.00	5.71	0.06	5.63	5.82	0.951	0.007	0.942	0.962
67 days[c]	28.87	1.61	5.51	0.04	5.46	5.57	0.941	0.008	0.925	0.951
74 days[d]	34.94	0.00	5.49	0.01	5.47	5.50	0.924	0.007	0.916	0.933
90 days[e]	37.56	0.27	5.58	0.02	5.56	5.63	0.919	0.009	0.901	0.928

[a]: End of cold phase. Includes 2 days at 18ºC for drying after the application of sorbate solution.; [b]:After 12 days drying at 3ºC; [c]:After smoking; [d]:After pressing the product; [e]:End of process

Table 1.
Fenalår characteristics through the elaboration process

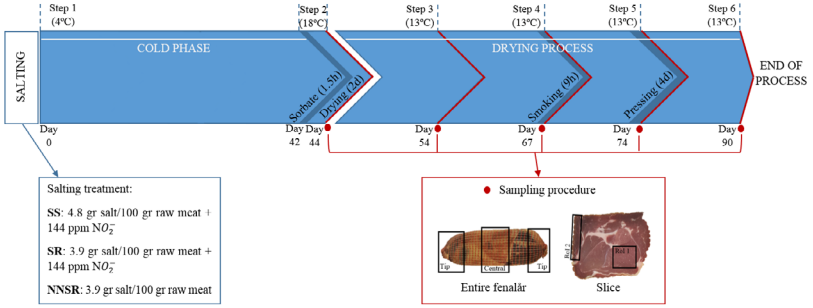

Figure 1:
Fenalar elaboration procedure and sampling.

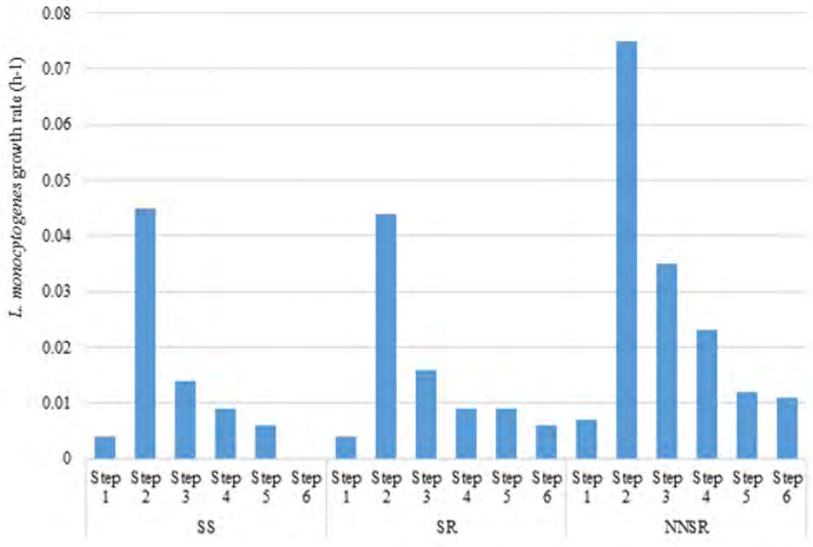

Figure 2.
Influence of the elaboration procedure and phase temperature/duration on the growth rates of *Listeria monocytogenes* in fenalår (expressed as Log_{10} cfu/g increase per h).

Notes