Predicting frying times in recently fried potato fries using imaging spectroscopy and Partial Least Squares Discriminant Analysis (PLSDA)

M. Bertotto, E. Hogeveen, T. Verkleij, R. Hamoen, G. Polder

Background and aim of the study

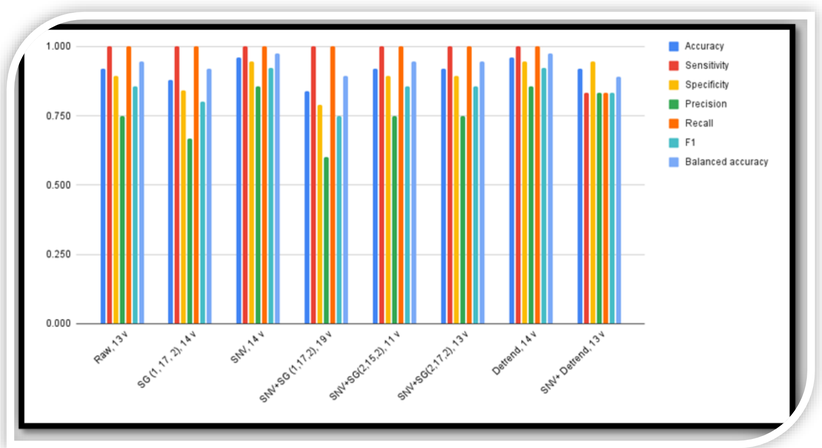
Different methods used to identify (possible) causes of internal and external texture were summarized by R.G.M. van der Sman et al (2022). We suggested the use of FTIR imaging (HIS) to measure potato fries under different conditions, as a preliminary study, because HSI has many advantages compared to other texture methods. Firstly, information on the chemical and physical structure of the product is obtained through its infrared spectrum (which provides a fingerprint). Moreover, spatial information is also acquired. Furthermore, this method is non-destructive, non-invasive and requires little effort by the operator. The aim of this study was to evaluate the performance of imaging spectroscopy to classify fries samples according to their frying time (3 and 5 minutes).

Materials and Methods

Ninety frozen potatoes, round cut, pre-fried in sunflower oil, were finally fried for 3 and 5 minutes, then cooled for 10 minutes and immediately measured by a spectral camera (Specim FX17, spectral range: 937.33 nm to 1718 nm).
All images were converted to .mat format in MatLab using an inhouse developed function. Then, spectra were extracted from the images, from core and crust, using Hypertools version 3 in MatLab. Typical chemometrics analysis was performed in R version 4.2.
Samples were distributed in two classes according to the frying time: **class 1 (3 minutes)** and **class 2 (5 minutes).** Three classification models were calibrated and validated: a) One model to classify 3 min from 5 min fries using 90 spectra from the cores; b) One model to classify 3 min from 5 min fries using 84 spectra from the crusts; c) One model to classify cores from crusts, using all measured spectra (not shown here).

Results

Figure 1. Classification metrics of the prediction in the validation set, using different spectral pretreatments.



Results

- The best models were achieved using PLSDA, results can be seen in Table 1.
- Core: SNV, then 12 variables selected by CovSel, PLSDA with 8 latent variables (LV).
- Crust: Detrend, then 14 features selected by CovSel, PLSDA with 12 LV.

Figure 2. Mean NIR spectra of core and crust, for both studied conditions

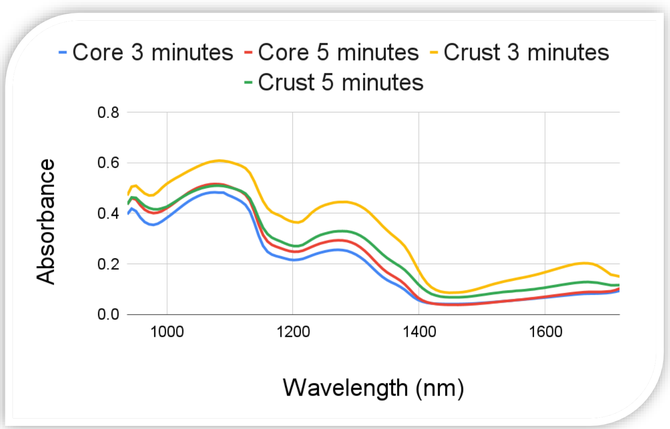


Figure 3: Score plots of PLSDA classification models

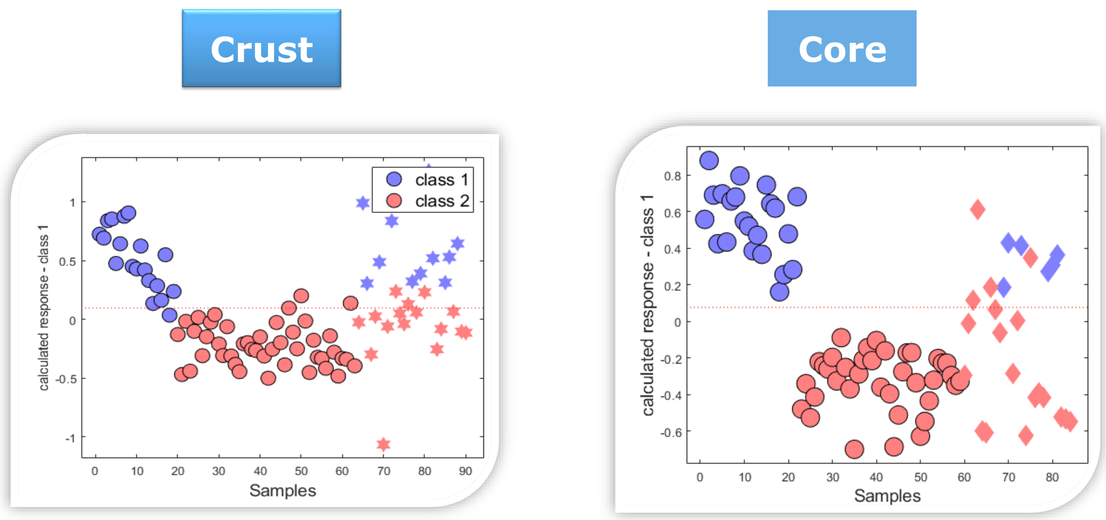


Table 1: Classification metrics of the prediction in the validation set.

Model	Set	Real/pred	3 min	5 min	Sensitivity	Specificity	Precision	Accuracy
CORE	Cal	3 min	16	3	0.84	0.93	0.84	0.95
		5 min	3	41	0.93	0.84	0.93	
	Val	3 min	11	0	1.00	0.81	0.79	0.89
		5 min	3	13	0.81	1.00	1.00	
CRUST	Cal	3 min	19	3	0.86	0.97	0.95	0.98
		5 min	1	36	0.97	0.86	0.92	
	Val	3 min	5	1	0.83	0.95	0.83	0.92
		5 min	1	18	0.95	0.83	0.95	

Conclusions

Imaging spectroscopy together with chemometrics is a reliable method to accurately classify pre-fried potato fries depending on their frying time (3 and 5 minutes).

Wageningen University & Research
P.O. Box 123, 6700 AB Wageningen
Contact: name.surname@wur.nl
T + 31 (0)317 12 34 56, M +31 (0)6 12 34 56 78
www.wur.nl/xxxxx