Fingerprinting meat and plant-based burgers under smart-NIR rays

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Objectives: Rapid indirect methods are most needed in new foods processes as in plant-based burgers, but rheological analyses are expensive and time consuming. NIR spectroscopy can help in the development of chemometric models for a simulator of food quality as presented in this paper.

Materials and Methods: Two commercial (CB, CE) and seven produced (P1¸P7) plant-based and one meat (MT) types of burgers, for a total of 100 samples were analyzed with a portable NIR to measure 70 quality traits. The plant-based burgers were based on pea protein.

The raw and cooked samples, lyophilized and powdered, were examined in reflectance mode by a miniaturized NIRS web-based

wireless spectrophotometer (SCiO mini TM v. 1.2, Consumer Physics) in the range of 740–1070 nm (331 points).

The spectra were imported with the WinISI II v1.04 software and processed, after math transformation in Log (1/R) and first derivation, by means of the modified partial least squares (MPLS) method, and systematic cross-validation. The 1-VR coefficient and the RPD (standard deviation / error in cross validation) values were retained as performance indicators in predictability of a panel composed by 29 rheological variables [1], and 41 chemicals pertinent to 10 replicates of the 10 types.

To assess the different fingerprinting ability (typability) in the NIR spectra the MPLS method was applied to the identity matrix where each class was treated as binary, coded as 1 if present or 0 if absent. A series of 10 equations was built, where the optimum number of latent variables was determined by a crossvalidation procedure, including all the N observations except few outliers (t>3.5). Then the 10 equations were applied to the whole set of 200 spectra (raw and cooked), resulting 10 PLS-Solutions (PLS- Sol) [2] for each sample. For eliminating negative values, the PLS-Sol were squared. This makes it possible to compare the different classes under study in the subordination to their typability: a low PLS-Sol means poor identifiability of that class in comparison to the typability of the other classes. Otherwise, a high PLS-Sol rating depends on fingerprint characteristics of the spectra in that class. Typability is different from a discrimination-classification method: it represents the rank of each class compared to all the other and not by couple as in a classification matrix. Paradoxically, if each class were 100% classifiable, the average PLSSol value would be the same for all classes and in any case not significantly different from zero. To assess the significance of typability between the classes, due to a presumed non-normal distribution of the errors, a non-parametric Friedman's test for the N paired samples was computed in the EXCEL spreadsheets. Results were expanded with the XLSTAT statistical software, by a multiple pair- wise comparisons using Nemenyi's procedure/Two-tailed test, and the P-values for each class comparison were assigned to the sum of ranks.

Results and Discussion: typability from raw and cooked burgers were quite similar since in both cases the P1 to P7 types showed poor PLS-Sol, graduated in 2 steps, while the meat and the CB and CE burgers received very high and similar PLS-Sol. Obviously, the CB, CE and MT burgers were very different from each other as the 1-VR coefficients among the couples were over 0.99. As in a metaphor, NIRS typability is like examining from the plain a profile of differently elevated mountains, among which the salient points emerge from the horizon. As expected, the NIR spectra resumed important knowledge about the 29 rheological measured traits with average 1-VR 0.71±0.16 and RPD 2.12±0.65 where 15 variables resulted at RPD > 2. Even better emerged for the 41 chemical traits [1-VR 0.86±0.11 and RPD 4.16±2.61(with 38 RPD > 2)].

Conclusions: In a new product design phase with the aim of emulating already well-known products, e.g., meat burgers, NIR spec- troscopy could be a useful tool that could increase the productivity of this phase of innovation and research with extremely low cost and short time.

The obtained results are very promising, and studies are underway to increase the database of spectra and product types.

References:

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