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Detection of irradiated dry fermented sausages by near infrared spectroscopy (#14)

Maria Olga Varrà[1], Luca Fasolato[2], Sergio Ghidini[1], Adriana Ianieri[1], Enrico Novelli[2], Emanuela Zanardi[1, 3]

[1] University of Parma, Department of Food and Drug, Parma, Italy; [2] University of Padova, Department of Comparative Biomedicine and Food Science, Padova, Italy; [3] E-mail: emanuela.zanardi@unipr.it, Parma, Italy

Introduction

Food irradiation can be used to increase the food safety and to extend shelf-life of a wide range of foods. In recent years European pig meat producers have expressed a growing interest in the feasibility of irradiation technology to improve the safety of meat products intended for export in some markets where public health policy have established a zero tolerance in ready-to-eat foods for some pathogens. In the EU the only category of foodstuffs that may be treated with ionizing radiation is "dried aromatic herbs, spices and vegetable seasonings". The availability of analytical methods is pivotal for the official control systems to assess the compliance with regulatory requirements and prevent food fraud in the national and international markets. The aim of the present study was to explore the possibility of applying near infrared spectroscopy (NIRS) in combination with chemometric analysis to dry fermented sausages to achieve the distinction between irradiated and non-irradiated specimens and to classify them according to the irradiation dose.

Methods

Salame Milano were sliced and aliquots of 2-slices each were vacuum packed. Fifty bags were randomly chosen for comparison purposes (C, control, n=50) and forty were randomly allotted in four groups intended for irradiation treatment at 0.5, 1, 2 and 3 kGy irradiation dose, respectively (T, treated, n=40 each). Irradiation was performed using a ^{60}Co -irradiator (1.17–1.33 MeV). The samples were stored for 30 days at 5°C prior to analysis. The NIRS spectra of each samples were recorded in the 1000–2500 nm region by means of a NIRFlex® N-500 (Büchi Labortechnik AG, Switzerland) instrument. The 1000-1249 nm region, characterized only by the noise, was removed from the dataset. A total of 210 salami spectra and 1251 wavelengths were included in the final spectral data matrix. Multivariate data analysis was performed by using the chemometric software SIMCA-P (Umetrics, Sweden). Firstly, a principal component analysis (PCA) was computed on the NIRS pre-treated data. Then, orthogonal partial last square-discriminant analysis (OPLS-DA) was applied to classify samples on the basis of the irradiation dose. The Variable Importance in Projection (VIP≥1) scores for predictive OPLS-DA components were designed to find the strongest influence exerted by single absorption bands over samples classification.

Results

For PCA, internal cross validation allowed to extract 8 principal components (PCs), which explained 98.6% of the cumulative variance of the spectra, the first two PCs accounting for the major variability present in the dataset (90.2%). However, PCA, usually applied to explore NIRS data, was not suitable for a clear separation of samples treated with different irradiation doses. OPLS-DA algorithm was applied to the pre-treated spectra of the training subset by following a multi-step methodology: an initial OPLS model was intended to discriminate C from T samples; a second model was aimed at discriminating samples in different groups corresponding to the irradiation dose. Concerning the first approach, the two groups of samples C and T were perfectly separated in the bi-dimensional space (Figure 1). According to VIP analysis, the discrimination of samples was attributed mainly to lipids absorption bands at 1670–1750 nm, 2050–2070 nm, 2120–2200 nm regions and, above all, around 2420 nm, corresponding to the absorption of C–H groups during the second overtone. Classification rates of 100% for both C and T samples were achieved through the external validation which confirmed the accuracy of the model in prediction of the class the samples belonged to. Concerning the second model, the predictive variation extracted explained about 88% of the information related to the specific class membership of the samples, allowing to obtain a perfect separation among samples of different groups and a high degree of clusterisation among samples of the same group. Nevertheless, no distinct clusters were observed among the control (0 kGy) and the lowest-irradiated (0.5 kGy) samples (Figure 2). However, model's overall classification performance of 74.6% in external validation was satisfying. In this contest, the samples exposed to 1 and 3 kGy irradiation doses were 100% correctly allocated in their class, while the weakest statistical performances were shown by samples exposed to both 0 and 0.5 kGy irradiation doses; the highest error of classification was recorded for 0.5 kGy samples, since only 41.7% was assigned to the proper class.

Conclusion

NIRS combined with chemometric analysis allowed to build two robust classification models able to discriminate dry fermented sausages submitted to irradiation treatment in the range 0.5-3 kGy from non-irradiated ones.

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Notes

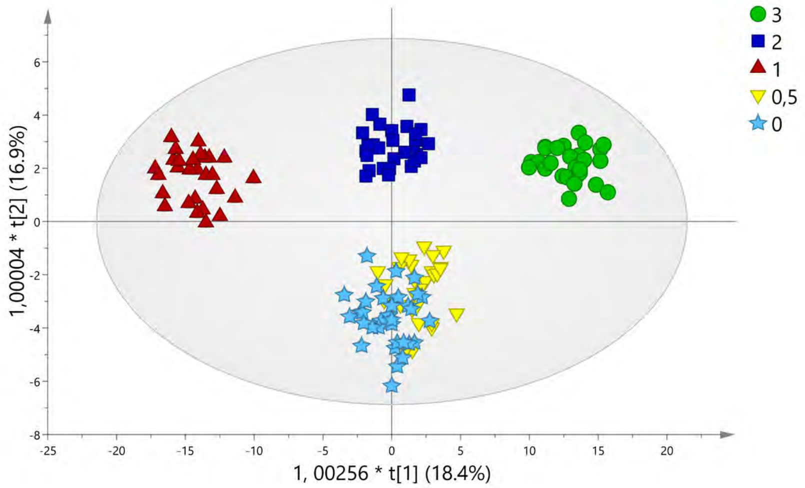

Figure 2.
OPLS-DA score plot for dry fermented sausages non-irradiated (stars) and treated at 0.5 (yellow triangles); 1 (red triangles);2 (squares) and 3 (circles) kGy irradiation dose.

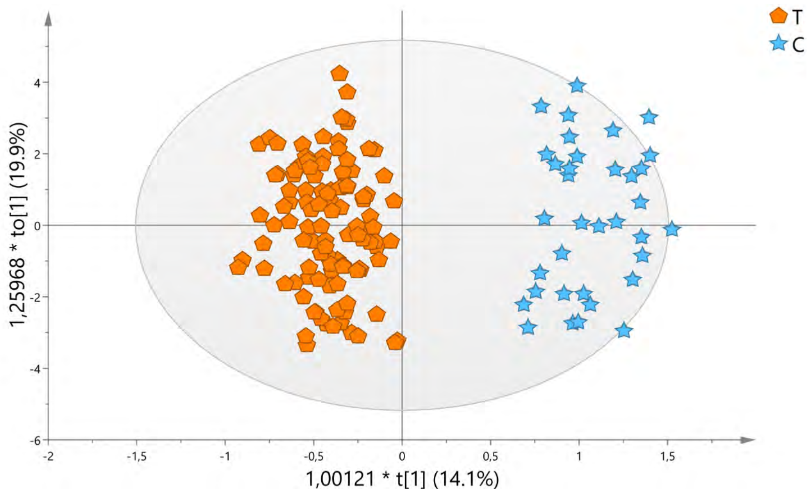

Figure 1.
OPLS-DA score plot for dry fermented sausages non-irradiated (C, stars) and irradiated (T, pentagons).

Notes