Application of Raman spectroscopy for fatty acid and boar taint determination

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Introduction: Raman spectroscopy is based on the evaluation of the inelastic scattered light obtained from the monochromatic light irradiation of samples. A previous work has shown its feasibility to separate between high and low levels of boar taint (Liu et al., 2016) when fat came from pigs of the same genotype and fed the same diet. Several works show the possibility of predicting fatty acid composition in pork with Raman (Berhe et al., 2015; Olsen, et al., 2007). In the present work, the aim is to determine the feasibility of Raman spectroscopy to determine the compounds responsible for boar taint, androstenone and skatole, and the fatty acid composition in fat from pigs of different genotypes and a wide range of androstenone and skatole levels.

Materials and methods: A total of 84 fat samples were collected at the slaughter plant ensuring to have different boar taint levels. The adipose backfat tissue sample was analyzed to determine the androstenone and skatole levels by means of stable isotope dilution analysis using HS-SPME-GC/MS (Elfi Analytic, DE). Fatty acids were determined using gas chromatography (GC-FID) after lipid extraction. Saturated (SFA), monounsaturated (MUFA), and polyunsaturated (PUFA) groups were calculated.

Samples were evaluated in quadruplicate with Raman device (Fat Boy Laser Module, Innovative Photonics, USA). Raman spectra were collected with a detector (Ocean Optics HR2000 spectrophotometer, Ocean Optics, USA) in a range between -39 to 2303 cm-1 with a resolution of 8 cm-1, 6 s of integration time, ten accumulations per spectrum and laser power of 50 mW.

Data analysis was performed with PLSToolbox (MathWorks) using a range of 700 to 1800 cm^{-1} after removing the outlier spectra. Several pre-processing methods were evaluated: baseline, standard normal variate (SNV), extended multiplicative scatter correction (EMSC), and 1st and 2nd derivative Savitzky-Golay to find the best prediction equation. PLS regression was carried out considering all the variables as predictors or a selection of them, obtained with the iPLS or choosing those with variance importance for prediction (VIP) value higher than 1.

Results: Prediction of androstenone and skatole content has been evaluated. The root mean squared error of prediction (RMSEP) was approximately 0.17 µg/g for skatole and 2.43 µg/g for androstenone. The coefficient of determination was very low for both compounds.

Regarding the prediction of fatty acids, MUFA and PUFA were predicted with a RMSEP of 2.15 % and 2.22 %, respectively. The R^2 after cross-validation leave-one-out was 0.37 and 0.58, respectively. The prediction of SFA was not accurate.

Conclusions: As a preliminary result, Raman spectroscopy can be used to predict the fatty acid composition but the accuracy to predict androstenone and skatole contents is very low. However, more work has to be done in the data pre-processing and selection of predictors in order to improve the accuracy of the prediction equations.

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