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Determination of marker compounds of lipid oxidation in foal meat by spectral mid infrared measurements (#203)

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Introduction

Foal meat has particular characteristics that make it a very attractive product for the consumers, since it has excellent nutritional properties and because it has a sustainable production system. Applicability of various traditional methods and techniques to measure foal meat quality has been reviewed in literature. The objective of this study was to use the ATR-FT/MIR spectroscopy as a new technique to determine lipid oxidation marker compounds in foal meat.

Methods

For this study, seven foals from Galician Mountain and Burguete crossbreeding foals were used. Animals were kept with their mothers on pasture from birth to weaning at the age of 6-7 months. Then, foals were fed on a rotational grazing system that lasted 3 months (± 15 days). Finally, foals were supplemented for 104 days (± 10 days) with a finishing diet based on a linseed-rich concentrate (at 5%). Foals were slaughtered at 13 months of age and 24 hours *postmortem* meat samples from the *Longissimus dorsi* (LD) muscle were extracted from the left half of carcass. Samples were stored under vacuum packaging conditions and preserved 0, 4, 8 and 12 days. Lipid oxidation was calculated quantifying the thiobarbituric acid reactive substances index (TBARs) at the last stage of oxidation process (malonaldehyde content (MDA) (mg MDA/kg of meat)). The quantification of TBARs was performed for each of the samples and the resulting compounds were frozen-stored at -18ºC inside Eppendorf tubes® 3810X. MIR spectra were collected using a Fourier transform mid-infrared spectrometer (Vertex 80v, Bruker) between 4000-400 cm^{-1}. A total of 6 replicates were performed per sample. For each sample, 32 scans in the 4000–400 cm^{-1} spectral range were recorded with a resolution of 4 cm^{-1}. All measurements were performed with an Attenuated Total Reflectance accessory A225/QPlatinum-ATR (Bruker, Ettlingen, Germany) with a diamond crystal. The models were built by a Partial Least Square (PLS) regression and a specific program of chemometrics were employed, OPUS Quant v.7 (Bruker, Ettlingen, Germany). After the extraction of these marker compounds, a study of their absorbance spectra was carried out to establish prediction models (calibration and validation) between them and the conventional quantification of compounds in order to decide whether it would be helpful to estimate the values of this type of marker compounds directly using MIR measurements on raw meat samples, or whether it would be better to carry out a previous extraction of these compounds before proceeding with their MIR analysis. The descriptive statistical analysis was performed using IBM SPSS Statistics 25 software.

Results

The main productive variables of the foals as average daily gain during the finishing period and the dressing percentage (mean ± standard desv.) achieved 733g/day ± 0.19 and 53.1% ± 3.05, respectively. The physic-chemical analyses of the foal meat samples (mean ± standard desv.) were: 74.1% ± 0.81 for moisture, 22.75% ± 1.12 for protein, 0.66% ± 0.34 for fat, and 1.32% ± 0.09 for ash. With regard to lipid oxidation (mg MDA/kg of meat), figure 1 shows the lipid oxidation evolution in foal meat over different days of storage (0, 4, 8 and 12 days). From these results, there is not a clear behavioral pattern followed by the samples. Foal 3 and foal 7 followed a clear and rising lipid oxidation pattern related to sample aging. This means that, as the sample aging increased (0-12 days), the total MDA content increased.In terms of the spectral characteristics of lipid oxidation marker compounds, figure 2 contains the typical spectrum obtained by FT-MIR analysis of a TBARs sample. The most remarkable one is the band located between 3700 cm^{-1} and 3100 cm^{-1}. This area corresponds to the wide band of high absorption associated with the hydroxyl groups O-H of water. Apart from this, the band with the highest absorption appears in the region between 1680 and 1590 cm^{-1}, with the highest peak at 1636 cm^{-1}. This area corresponds to the stretching vibrations of C=H groups (Alkenes). However, it is also known that the peak at 1640 cm^{-1} corresponds to the hydrogen covalent bonds bending of water. Thus, the results are not sufficiently clear to identify the type of bond that causes that absorbance. To determine the marker compounds by MIR spectroscopy, the results of these spectra were compared with those of raw foal meat, using chemometric analyses. Table 1 shows the results of the predictive models of calibration and validation of the TBARs marker compounds. From these data, it is highlighted that the results of the marker compounds showed more consistent predictive models than the ones found in the quantitative analysis of the spectra obtained from raw meat. In this regard, the predictive model of lipid oxidation compounds obtained in this study presented an initial R^2cv of 63.18% in the samples TBARs Entire Set as compared to R^2cv of 2.43% found in raw meat.

Conclusion

Notes

To conclude, it has been shown that the prior extraction of marker compounds significantly helps to achieve more consistent results for the evaluation of lipid oxidation in foal meat products.

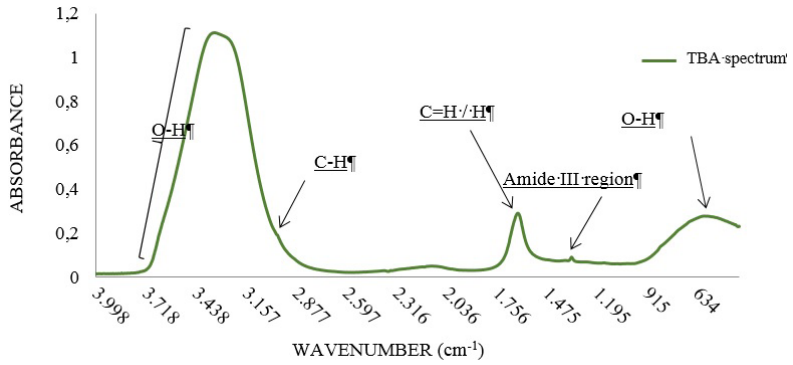

Figure 2. Spectral characteristics of lipid oxidation marker compounds in foal meat.

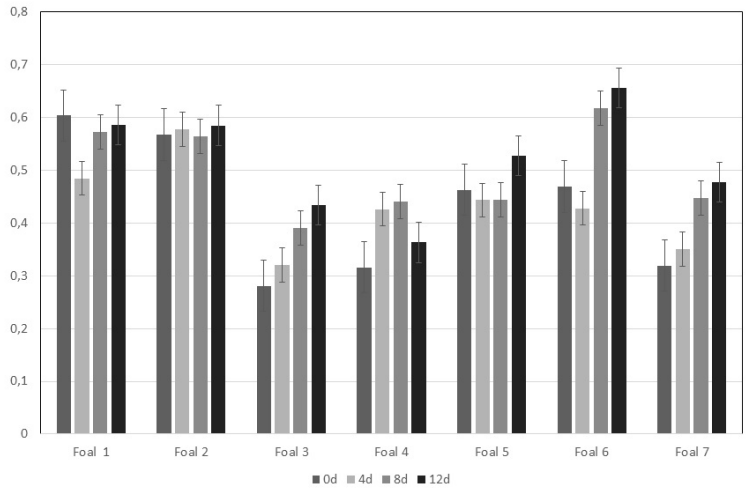

Figure 1. Evolution of lipid oxidation (mg MDA/kg meat) over 0, 4, 8 and 12 days.

	Parameter	TBARs Raw Meat Samples	TBARs Entire Set
Calibration	R^2	9.96	75.19
	RMSEE	0.143	0.338
	RPD	1.05	2.01
	Rank	1	10
Validation	R^2_{cv}	2.43	63.18
	RMSECV	0.146	0.402
	RPD_{cv}	1.01	1.65
	$Rank_{cv}$	1	10

R2: Coefficient of determination for calibration
RMSEE: Root mean square error of calibration
RPD: Residual Prediction Deviation
Rank: Number of Partial Least Square factors
R2cv: Coefficient of determination for cross validation
RMSECV: Root mean square error of cross-validation

Table 1. Results of the predictive models (calibration and validation) of the TBARs Marker Compounds

Notes