

COLOR PARAMETERS PREDICTION IN BEEF CATTLE USING TIME-DOMAIN NMR WITH CHEMOMETRICS

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Introduction

Time domain nuclear magnetic resonance spectrometry (TD-NMR) is based on small (bench top), low field and inhomogeneous permanent magnets. In this technique, the difference between analytes is based on the variation of longitudinal (T_1) and/or transverse (T_2) relaxation times. For these measurements, the NMR signal is obtained using multiple pulses sequences, for instance Carr-Purcell-Meiboom-Gill (CPMG) that is fast (less than 1 s in some cases) and generates an exponential signal that decays with T_2 .^{1,2} Color measurements is a relevant parameter of quality control for the evaluation of shelf life of goods, mainly in meat industry. The meat color is represented by ca. 90% of metmyoglobin content and the remaining 10% is related to hemoglobin and also, other variations of metmyoglobin. Metmyoglobin is the oxidized form of hemoglobin and it is the reason of the brown color of meat that increases with age.³ Here, we develop a multivariate models to determinate the color of beef using TD-NMR relaxation data.

Results and Discussion

The CPMG decay signals were recorded using a benchtop SLK 100 TD-NMR spectrometer (Spinlock Magnetic Resonance Solution, Cordoba, Argentina) equipped with a 0.23 T permanent magnet (9 MHz for ^1H) and a 13 x 30 mm probe head. The computation of the partial least squares (PLS) regression models was performed using Pirouette 4.0 rev. 2 software package (Infometrix, Bothell, USA). The independent variables (X matrix) were the signals of TD-NMR and the dependent variables (Y matrix) were the reference values for lightness (L^*), redness (a^*), and yellowness (b^*) measured for *Longissimus dorsi* muscle using a Konica Minolta DL 65 Chroma meter CR400 (Konica Minolta Sensing, Osaka, Japan). Then, the reflectance response up 380 to 770 nm was the parameter used to estimate the metmyoglobin accumulation on beef cattle meat surface. The raw meat samples of twenty-six Nelore young bulls were analyzed by TD-NMR relaxometry using CPMG sequence. The signals were mean-centered and the 773 variables were selected from 1,500 to perform the models. The data of meat color

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values and TD-NMR signals were very high correlated with the following linear coefficients of regression (r) for L^* (0.9), a^* (0.7) and b^* (0.8). The values of root mean square error of cross validation (RMSECV) were in (a. u.) 1.0 for both L^* and b^* , and 1.9 for a^* parameter. The best model was for L^* using 4 latent variables with 100% of explained variance. The possibility to measure meat color opened by these models can be important for quality control of this type of food. Since the variations of meat color can indicate differences on chemical processes and consequently, alterations in the suitability of the product for the end consumer.

Conclusions

The method proposed in this study is properly able to measure the color of meat beef cattle with the following relevant features: high analytical frequency, low operating costs and equipment maintenance, easy-to-use, preservation of sample integrity. The analysis can be performed on bulk of the sample and through-packages. The method also offers the ability to perform direct analysis without the need for weighing the samples.

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