Comparison of methods to validate the prediction of ham and belly composition by magnetic induction scanner

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Introduction: Magnetic induction, which principle takes advantage of the dielectric properties of tissues, was tested by Swan et al. (2001) on bellies, hams and shoulders, by Simoncini et al. (2012) on hams and by Daumas et al. (2019, 2020) on bellies and hams. Statistical validation is an important stage in testing a technology, but there is no consensus on a method. The objective of this study was to compare the performance of five prediction methods of the composition of hams and bellies by magnetic induction.

Material and methods: Data for two calibration samples were used: one for 100 hams and the other for 80 bellies. Hams and bellies were scanned with a recent commercial device using a low-intensity magnetic field, called HAM-Inspector II™, which was developed by Lenz Instruments S.L. (Barcelona, Spain). The four response variables, weights and contents of fat and muscle, were measured by computed tomography according to the procedure developed by Daumas and Monziols (2011). Samples and estimation of tissue composition were presented by Daumas et al. (2019). The explanatory variables were numerous and presented collinearity.

The five prediction methods tested were Ordinary Least Squares (OLS), Lasso, Ridge, Partial Least Squares (PLS), and exhaustive selection of sub-models by minimizing the Bayesian information criterion (Subset). For each statistical method, R^2 and the prediction error were calculated in a 10-fold cross validation repeated 100 times with random division of the data into 10 segments. The tuning of all hyperparameters (number of PLS components, regularization parameter) was included in the cross-validation setup.

Results: Based on the median values, the PLS gave the best performance for hams and OLS the worst. PLS showed the lower dispersion of results and OLS the higher dispersion. The muscle content of hams was estimated with a R^2 of 0.64.

For bellies, PLS gave the worst results. Ridge regression was the most successful, except for fat content, for which Subset was better. The fat content of bellies was estimated with a median R^2 of 0.66. This value is much lower than the R^2 of 0.76 obtained during calibration by Subset too, which could be a possible consequence of overfitting.

Conclusion: The differences in cross-validated R^2 between the five statistical methods tested were found to be substantial. Of the five methods, none proved to be the best on both ham and belly samples. The ranking of methods based on their prediction performance depended on the cut. Subset, Ridge and Lasso seemed to show the most stable prediction performance results among the cuts and response variables, always being close or equal to the best performance.

These results are promising for further use of magnetic induction devices to grade bellies, and possibly other cuts.

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