Modelling consumer liking of lamb meat based on composition using chemical and rapid evaporative ionisation mass spectrometry methods

Carolina Realini [1], Alba Chaolumen [2], Dongwen Luo [3], Enrique Pavan [1,6], Renyu Zhang [1], Michael Agnew [1], Pat Silcock [4], Graham Eyres [4], Alastair B. Ross [5]

[1] Food Technology & Processing, AgResearch Ltd, Palmerston North, New Zealand, [2] Systems Biology Enabling Platform, AgResearch Ltd, Palmerston North, New Zealand, [3] Digital Agriculture, AgResearch Ltd, Hamilton, New Zealand, [4] Department of Food Science, University of Otago, Dunedin, New Zealand, [5] Proteins and Metabolites, AgResearch Ltd, Lincoln, New Zealand, [6] Unidad Integrada Balcarce, Instituto Nacional de Tecnología Agropecuaria, Balcarce, Buenos Aires, Argentina

Objectives: Consumer quality perception of meat is complex, dynamic and influenced by extrinsic attributes (e.g., price, origin, animal welfare, environmental impact), however, sensory characteristics remain the key purchase consumer criteria. Lamb *m. longissimus* from 6 typical New Zealand (NZ) production systems was characterized chemically and instrumentally and the association of consumer liking with individual data sets reported (Pavan et al., 2021; Zhang et al., 2022). The objective of this study was to model consumer liking of lamb combining the different objective analysis data sets (blocks). Two questions were explored by modelling: 1. Can lamb samples be discriminated based on their consumer overall liking scores combining different blocks of data? 2. Which data-block has more weight in sample discrimination?

Materials and Methods: DIABLO-multiblock sparse Partial Least-Squares Discriminant Analysis (sPLS-DA) method from the package mixOmics in R was used to integrate blocks of data (REIMS-rapid evaporative ionisation mass spectrometry: 984, FA-fat- ty acids: 28, RwVol-raw volatiles: 38, CkVol-cooked volatiles: 55) with consumer overall liking which has been classified into two classes: HIGH and LOW overall liking scores (100 mm nonstructured line scale, where 0=dislike extremely and 100=like extreme- ly) using a cut-off point of 70. The model classified 48 lamb samples from 6 typical NZ commercial animal groups (n=8 per group). Half of the lamb samples had HIGH (n=24, >70) and the other half had LOW (n=24, <70) overall liking scores (thus, the reference error rate was 0.50 for classification). Details about the production systems and consumer (n=160) evaluation were re- ported by Pavan et al. (2021). FA data were log transformed and zero or near-zero variance variables were filtered out from REIMS data. A design matrix with weights estimated from the data was chosen in the model to prioritize the discrimination of the outcome. The first component was selected by the model and variables selected for this component in each block were used to discriminate the overall liking. Overall results and results by blocks of data were plotted and model performance evaluated based on error rates.

Results and Discussion: The number of variables selected in the first component were 45 for REIMS, 7 for FA, 5 for CkVol and 20 for RwVol. The overall model classified the lamb samples into HIGH and LOW overall liking classes with 0.322 error rate, showing an improved classification accuracy from the reference value of 0.5. The classification accuracies assessed by the individual blocks of data showed increasing classification error rates in the following order: 0.338 using FA, 0.343 using REIMS, 0.381 using RwVol, and 0.412 using CkVol. Thus, the overall performance of the model using the four blocks of data showed higher classification accuracy compared with the individual data-blocks. Individually, the FA and REIMS data-blocks showed similar classification accuracy of the meat samples, followed by RwVol and CkVol blocks of data with higher classification error rates. Fatty acids and volatile compounds have been linked to meat sensory attributes. The similar sample classification accuracy using FA or REIMS could be attributed to the sensitivity of REIMS detecting mainly lipid components as fatty acids and phospholipids. REIMS pro- duces a more comprehensive compound profile (unique sample fingerprint) than those obtained by chemical analysis of FA, RwVol or CkVol, resulting in higher classification accuracy that the blocks of volatiles. Regarding the different classes of consumer overall liking, the overall model classified the HIGH class with higher accuracy than the LOW class (0.192 *vs.* 0.452 error rates), due to the broader variation in the selected variables for classification of LOW compared to HIGH samples. Similarly, the samples with HIGH overall liking scores were classified with higher accuracy than the LOW samples when using REIMS (0.178 *vs.* 0.508) or FA (0.238 *vs.* 0.438) data-blocks; while similar error rates were observed when using CkVol (0.418 *vs.* 0.406) or opposite results when using RwVol (0.488 *vs.* 0.273).

Conclusions: The multiblock sPLS-DA model improved the classification accuracy of lamb meat samples into HIGH and LOW consumer overall liking scores. Modelling using FA or REIMS data showed similar classification accuracy and higher than the RwVol and CkVol data-blocks, showing promising potential of REIMS as a rapid and cost-effective tool for lamb meat classification into eating quality classes. Further modelling will explore which variables across and within the different blocks of data had more weight in the discrimination of the overall liking of the lamb samples.

References:

Pavan, E., Y. Ye, G. T. Eyres, L. Guerrero, M. G. Reis, P. Silcock, P. L. Johnson, and C. E. Realini. (2021). Relationships among con- sumer liking, lipid and volatile compounds from New Zealand commercial lamb loins. *Foods* 10(5):1143.

Zhang, R., Realini, C. E., Middlewood, P., Pavan, E., & Ross, A. B. (2022). Metabolic fingerprinting using rapid

evaporative ionisa- tion mass spectrometry can discriminate meat quality and composition of lambs from different sexes, breeds and forage systems. *Food Chemistry*, 386, 132758.

Key words: Fatty acids, Volatiles, REIMS, Multiblock sPLS-DA