Prediction of marbling in Wagyu crossbred steers from crush data and metabolomics using machine learning

S. K. Connolly[A,BD], A.C. Dona[C], D. W. Hamblin[B], M. J. D'Occhio[A], and L. A. González[A]

[A]Sydney Institute of Agriculture & School of Life and Environmental Sciences, The University of Sydney, Camden, NSW 2570, Australia
[B]Hamblin Pty Ltd, 'Strathdale', Blue Mountain, Sarina, QLD 4737
[C]Kolling Institute of Medical Research, Northern Medical School, The University of Sydney, NSW 2065, Australia
[D]Email: samantha.connolly@sydney.edu.au

Marbling is a carcass trait that increases the tenderness, eating quality and flavour of beef (Gotoh *et al.* 2014). Metabolomics is an analytical technique that measures the small molecules in cells, tissues or bodily fluids (Goldansaz *et al.* 2017). Connolly *et al.* (2019) have previously shown significant relationships between marbling and blood metabolites measured in Wagyu steers 300-400 days before slaughter. Machine learning techniques could be used to develop prediction models to identify Wagyu steers with superior carcass attributes making the production system more efficient. The hypothesis of the present study was that on-farm measurements can be combined with metabolomics data to improve prediction of marbling in Wagyu crossbred steers.

On farm data included weaning weight, feedlot induction weight, age at induction, age at slaughter, growth rate, Wagyu percentage and sire. The metabolic data included 219 features or peaks some of which belonged to identified metabolites and some to unknown chemical compounds. Four machine learning methods were used to predict intramuscular fat or marbling measured at the 12/13th rib and then animals classified either as low or high marbling (Aus-Meat marbling score < 7 or ≥ 7, respectively). The machine learning methods included Naïve Bayes, Random Forrest and two Decision Tree methods (pruning the tree either using 1 standard deviation or according to tree depth). The data for both models was split into training (70%) and evaluation (30%), and results are presented for the later only. The Naïve Bayes and Decision Tree Depth model most accurately predicted marbling in model 1 using on-farm data only (Table 1). However, Naive Bayes showed the highest accuracy to predict marbling using both on-farm and metabolomics data (Table 1).

Table 1: Accuracy, sensitivity and specificity of predicting marbling in Wagyu crossbred steers using four machine learning methods (Naive Bayes, Decision Tree Classifier - 1 SE (standard error), Decision Tree Max Depth and Random Forests).

Model 1: On-farm collected data as predictors of marbling			
	Accuracy	**Sensitivity**	**Specificity**
Naïve Bayes	0.667	0.667	0.667
Decision Tree	0.500	0.467	0.556
Decision Tree Depth	0.667	0.567	0.833
Random Forest	0.604	0.900	0.111
Model 2: On-farm collected data and metabolomics data as predictors of marbling			
Naïve Bayes	0.833	0.833	0.833
Decision Tree	0.646	0.767	0.444
Decision Tree Depth	0.688	0.767	0.556
Random Forest	0.646	0.867	0.278

Results of the present study demonstrate the potential of metabolomics to improve prediction of marbling in live animals comapred to using on-farm data only. Studies similar to the present could not be found. However, Gredell et al. (2019) utilised differnet machine learning models to predict meat quality traits and tenderness was predictws with 81.4-90.8% accuracy from Rapid Evapouration Ionisation Mass Spectrometry data. In the present study, the ability of the machine learning models to predict marbling on the live animal were enhanced by the inclusion of data collected on-farm and metabolic data in crossbred Wagyu steers. However, further evaluation on an external dataset would be required before the model could be commercially utilised.

References

Connolly SK, Dona AC, Wilkinson-White L, Hamblin DW, D'Occhio MJ, & González LA (2019) *Scientific Reports*, **9**, doi: 10.1038/s41598-019-51655-2

Goldansaz, SA, Guo AC, Sajed T, Steele MA, Plastow GS, & Wishart DS (2017) *PLoS ONE*, **12**, doi: 10.1371/journal.pone.0177675

Gotoh T, Takahashi H, Nishimura T, Kuchida K & Mannen H (2014) *Animal Frontiers*, **4**, 46-54. doi: 10.2527/af.2014-0033

Gredell DA, Schroeder AR, Belk KE, Broeckling CD, Heuberger AL, Kim SY, King DA, Shackelford SD, Sharp JL, Wheeler TL, Woerner DR, Prenni, J. E. (2019) *Scientific Reports*, **9,** 5721. doi: 10.1038/s41598-019-40927-6