Snapshot Report

IMF of Primals

IMF of Primals – End of Processing Line measurement Using NMR (Stage 2)

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2021-1264

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Project Description

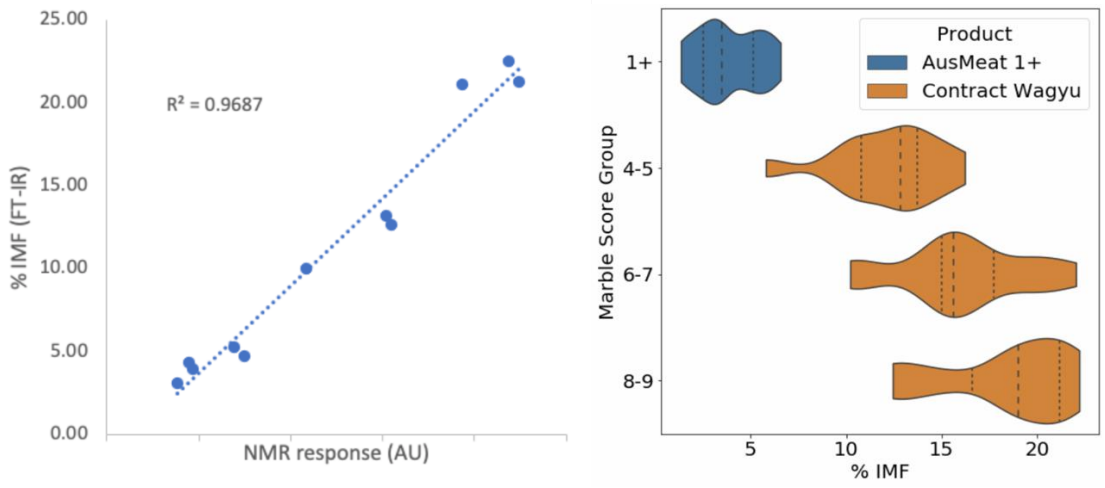
This project conducted intramuscular fat (IMF) measurements of subprimals in a beef boning room using a proof-of-concept tool, including a bespoke magnetic resonance sensor. This project required us to identify an application, confer with processors, adapt the system for the new application, conduct a trial, and finally produce an automation concept. These steps were broken down into six milestones with a stage-gate after surveying interest of processors.

This project was the second stage of bovine IMF measurements (McCarney and Webster, 2021). In the first project we investigated what was needed to adapt a magnetic resonance sensor designed for lamb to beef. That project included an outline of how a beef carcass grading system could be achieved. Following on from this we proposed the current project to progress from the earlier destructive sampling work used in 2019 (Pooke and McCarney, 2019) to non-destructive measurements.

Project Content

Data was collected using a tool that was a combination of a Marbl™ single-sided magnetic resonance sensor with a Matipo spectrometer and a user interface that was developed within the project. First, we assessed primals for fit into the sensor. Then we measured samples in the workshop to evaluate primals that we expected would be of interest. Data was systematically collected on a set of primals and sub-primal, using the updated Marbl™ sensor design, with the goal to evaluate the accuracy, reproducibility, repeatability, and variation within the primal. The data was used to directly predict % IMF. We focused on the striploin data because we had independent marble scores. On a limited number of samples in the workshop we showed the measurements were repeatable, reproducible with accuracy such that graded-product could be differentiated. Outcomes from these measurements were shared with processors that were surveyed.

On-site, measurements were conducted in a boning room with a two conveyor, forequarter and hindquarter, layout. Again we measured striploins. We measured samples from one shift of wagyu with a BMS range of 4-9, and one half shift of 1+ BMS resulting in >10 measured striploins in the 1+ (N=22), 4-5 (N=14), 6-7 (N=12), and 8-9 (N=11) AusMeat marble score groups. We predicted % IMF using a linear model created from 11 reference samples, where five were in the 1+ and two were in the 4-5, 6-7, and 8-9 marble score groups. The reference measurements showed a correlation of 0.97 and RMSEP of 1.3% IMF, which puts the performance on par with the gold standard measurement with the added benefits of being non-destructive, fast, and on-site.



Correlation of NMR response with % IMF measured by the gold standard method (left). Violin plot showing occurrence density of predicted % IMF values on the x-axis within each marbling group along the y-axis (right).

Figure 1 shows a clear trend of increasing % IMF as the BMS increases, as would be expected. In the violin plot, the BMS 1+ only overlaps with a single outlier of the 4-5 wagyu group. The wagyu 4-5 and 6-7 groups do not overlap their 75% and 25% quartiles. The 6-7 and 8-9 see more overlap, however, the medians remain outside the quartiles of the other group. This overlap trend agrees with our understanding that grading becomes more difficult as marbling increases. Relative error was determined for each sample by determining the standard deviation from multiple measurements of the same striploin relative to the mean.

In the boning room, the time required to make the %IMF measurements limits the application to selected cuts. So, for automated measurement those cuts would need to be identified on the main conveyor, selected, measured and returned to the main belt. Following the consideration of three generic automation concepts, it was decided that a '3-conveyor' system would provide the simplest and most robust solution that satisfied the needs identified.

Project Outcome

In-line with the objective of this project, proof-of-concept % IMF measurements of beef subprimals have been made in the boning room. The Marbl™ sensor showed that measurements are achievable and the results repeatable and reproducible.

Benefit for Industry

The industry is seeking methods to objectively measure traits that are currently subjectively graded. Here, magnetic resonance was shown to be an objective, non-destructive measurement method that closely matches the performance of the gold standard IMF measurement used for accrediting %IMF methods. This is a tool that can be used in the boning room to relate % IMF measurements with subjective grading of beef marbling scores. More detailed work is however required to translate % IMF measurements into additional value for processors when measurements are made in the boning room.

This work progresses a path to non-destructive grading of hot beef carcases. Over the duration of this project, processors were clear in the view that tools for hot carcass grading are needed. Knowing this early in the project allowed us to explore hot grading as an additional application.

Resources

McCarney, E., Webster, B., 2021. Bovine IMF: Stage 1 for a Non-destructive prototype (No. 2021–1128). Australian Meat Processor Corporation Ltd.

Pooke, D., McCarney, E., 2019. NMR Measurement of Intra-Muscular Fat (No. V.RDP.2110). Meat & Livestock Australia Limited.