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Classement des carcasses pour la durabilité de la filière viande bovine et ovine. Partie I.

Classement des carcasses pour la qualité et l'efficacité afin de garantir la durabilité de la filière viande bovine et ovine dans le futur. Partie I.

Mots-clés : carcasse, bovins, qualité, ovins.

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Cet article est un compte-rendu de la session 18 du 74ème congrès européen des sciences animales (European Federation of Animal Science (EAAP)) qui s'est tenu à Lyon du 28 août au 1er septembre 2023 conjointement avec le congrès de l'association mondiale de la production animale (WAAP).

Résumé :
Cette session, qui s'est tenue lors du récent congrès joint EAAP/WAAP à Lyon, a permis de présenter des résultats de recherche sur le classement des carcasses pour prédire la valeur réelle des carcasses, qui est le produit de la qualité sensorielle des pièces de boucherie vendues (déterminant le prix/kg) et du rendement en viande maigre qui, lui-même, prédit les poids des différentes pièces de viande. Les résultats montrent clairement qu'il est possible de développer des systèmes de classement commercial plus sophistiqués étayant la véritable valeur des carcasses en utilisant à la fois des technologies de classement des carcasses traditionnelles et modernes, étroitement liées à la prédiction de la qualité gustative à l'aide de tests sensoriels avec des consommateurs non entrainés. Les nouvelles technologies de classement basées sur des appareils à rayons X et sur des caméras, combinées à des normes statistiques rigoureuses, conduiront à des précisions améliorées et même à de nouveaux critères tels que la teneur en gras intramusculaire mesurée chimiquement pour remplacer le classement visuel du persillé par l'homme. Cela facilitera également l'utilisation systématique des caractéristiques des carcasses pour étayer les programmes commerciaux d'évaluation génétique.

Abstract: Carcase grading for quality and efficiency – underpinning future sustainability of beef and lamb. Part I.
This session presented at the recent combined EAAP/WAAP in Lyon described research on carcase grading to predict the true carcase value which is a product of eating quality of the cuts sold (determining price/kg) and lean meat yield determining the amount of meat sold. The results clearly show that it is possible to develop more sophisticated commercial grading systems underpinning true carcase value by using both traditional and new carcase grading technologies, importantly linked to the prediction of eating quality using untrained consumer based sensory testing. The new grading technologies based on X-ray and vision-based devices combined with rigorous statistical analysis, will lead to improved accuracies and precision. Even new traits like chemically measured intramuscular fat may replace human based visual grading of marbling. This will also facilitate carcase traits to be routinely used to underpin commercial genetic evaluation programmes.

INTRODUCTION

The Beef and Lamb industries are under societal challenge to become more consumer focused in terms of delivering quality meal solutions at price points which match expectations. In addition, production efficiency in terms of kgs of meat produced from a carcase in association with transparent pricing structures requires sophisticated grading to measure lean meat yield. Indeed, it has been argued that true carcase value is a product of eating quality which determines price (Euro/kg) and lean meat yield which determined the kgs of meat sold (Pethick *et al.*, 2021). This session presented at the recent combined EAAP/WAAP in Lyon addressed these issues with speakers from Europe, South Africa, Brazil and Australia. Research was presented in relation to carcase grading for eating quality, and lean meat yield and new technologies for more precise measurement of the important carcase traits were introduced. Finally, the importance of defining the traits precisely from an industry perspective was presented including the incorporation of traits into genetic evaluation systems.

I. EATING QUALITY PREDICTION UNDERPINNED BY CONSUMER EVALUATION

Meeting consumer expectations: A 3G Global Beef Eating Quality predictive model for Europe

The meat industry faces several challenges and consistent, predictable eating quality is one of them. In Europe, the actual EUROP commercial grading system for carcass conformation and fat distribution doesn't align with consumer's meal experiences. This was proven over the past 15 years with meat eating quality research trials using untrained consumers across Europe. Since 2017, the collaborative platform hosted by the International Meat Research 3G Foundation (IMR3GF, Hocquette *et al.*, 2020) has compiled the data collected using UNECE Beef Eating Quality protocols. The IMR3GF members comprise leading scientists from several countries who have collaborated extensively to assemble consumer and animal data across many countries and over 25,000 European consumers. The approach was to work with UNECE to create common standards for meat products and sensory evaluation to ensure data were compatible and able to be merged to create sufficient scale from which reliable consumer sensory estimates could be developed. These data have enabled the Foundation to develop a European predictive model based on research trials. The database contains data connecting cattle, carcase treatments, cuts and cooking styles to consumer answers on eating quality. This represents consumer studies conducted on 11 muscles over the last decades in European countries (Poland, France, England, Northern Ireland, Wales, Ireland). The database contains a considerable number of variables characterising the carcass using the 3G Chiller Assessment method and the consumers sensory testing according to the UNECE standards. The predictive model is an evolutive tool with further eating quality accuracy and scope developed with greater data. As all industry revenue directly relates to the consumers judgement of value, with the most critical component meal satisfaction, industry profitability can be enhanced by delivering consistent eating quality through strong commercial brands built on a solid scientific foundation.

Development of a carcass grading system for South African beef

The South African red meat industry is diverse in terms of production systems, landscape, climate, breeds, age, sex, feeding regimes, external parasite loads, growth stimulant use (hormonal and beta-agonists) and management practices; each providing its own influence on the quality of meat provided to the consumer. This diversity in conditions often makes it difficult to identify strong correlations between single intrinsic factors and meat quality attributes. Due to this complexity, there is paucity in the understanding of the exact factors which influence meat quality. Currently, no method exists which can effectively and consistently predict or ensure the eating quality of the meat which is produced within South Africa. To develop a quality grading model within South Africa, a developing country, the effect of animal inputs unique to South Africa on the eating experience of the consumer, needs to be determined. These unique inputs include local breeds (Sanga types), growth stimulant use (beta-agonists and hormonal growth promotants), sexes (predominantly young bulls) and traditional production methods (grass-fed & feedlot raised) which have not been included in the Meat Standards Australia (MSA), International Meat Research 3G Foundation (IMR3GF) or other international grading model developments, yet (Hocquette *et al.*, 2022). A matrix of animals (n=276), inclusive of the above-mentioned attributes, were slaughtered as per current South African standards and data recorded utilising registered UNECE protocols and detailed in a study by Watson *et al.*, (2008). A total of 1980 beef cuts of varying quality were harvested to be subjected to consumer testing to determine eating quality as experienced by the South African population. Subsequent grading prediction scores were compared to the South African consumer's eating experience. The results will update the existing grading models of the IMR3GF and MSA and be utilised to develop the first of its kind grading system for South Africa. Once developed, the model will be implemented within one of the leading red meat value-chain companies and food retailers (the exclusive owner of the South African IP) within South Africa.

French consumer evaluation of eating quality of Limousin beef

The aim of this study was to evaluate the eating quality of 2 beef cuts (striploin and rump) from 102 Limousin cows. Carcasses were first graded according to the Meat Standards Australia (MSA) methodology at the 5th and 10th rib 24 h post-mortem by 2 chiller assessors. This allowed the prediction of the MSA index for the whole carcass (McGilchrist *et al.,* 2019), which is an indicator of beef potential eating quality. Muscle samples were then collected, sliced with a thickness of 2.5 cm, aged for 10 days and finally grilled according to the MSA protocol. A total of 480 consumers scored beef for tenderness, juiciness, flavour and overall liking on a 0 to 100 scale. In addition, consumers were asked to assign a quality rating to each sample: 'unsatisfactory' (2*), 'good everyday' (3*), 'better than everyday quality' (4*) or 'premium quality' (5*) with an average of 3,03 and 2,9 for striploin and rump. Observed MQ4 scores were calculated combining scores of tenderness, juiciness, flavour and overall liking according to the MSA protocol. MQ4 values for the 2*/3*, 3*/4* and 4*/5* boundaries were 54, 62 and 76 respectively. The MSA index ranged from 45.5 to 58.5 and had a median value of 51,33. The marbling scores at the 5th and 10th ribs were positively correlated with the MSA index (0.34 and 0.47 respectively). Finally, beef carcasses were divided into two equal groups (under or above the median MSA index). The MSA index and the marbling score were 13% and 15% higher respectively in the second group of carcasses while rib fat thickness was 88% higher. Scores for tenderness, juiciness, flavour and overall liking as well as MQ4 were on average 9 to 13% higher for the rump and 5-10% higher for striploin in the second group compared to the first one. Overall, the results showed that the Australian MSA model might be relevant for Limousin cows but may require improvements for carcass grading at the 5th rib.

BeefQ - Testing a beef eating quality prediction system for Wales and England

The BeefQ project was implemented to address industry and consumer concerns around beef eating quality consistency. To adapt the Meat Standards Australia (MSA) model for UK conditions, consumer taste testing beef was conducted using the standard protocol developed in Australia (Watson *et al.,* 2008). Four cuts (sirloin, tenderloin, salmon and feather blade) from 90 sides of beef were evaluated as grilled steak by 1,200 Welsh and English consumers. Carcase suspension method and 7 and 21 days maturation were also tested. Cuts were collected in two seasons from cattle types typical of the Welsh herd (beef breed steers and heifers, dairy cross steers and heifers, young bulls and cows). Discriminate analysis determined the relationship between the individual consumer scoring scales of tenderness, juiciness, flavour and overall liking and provided a measure of the relative importance of each scale in determining the final quality decision.

Overall eating quality scores (an aggregation of scales above (1-100)) were used to determine cut off values for what consumers consider to be good everyday, better than every day and premium quality beef. The relative importance of each variable was 0.3 tenderness + 0.1 juiciness + 0.3 flavour + 0.3 overall liking. These weightings were similar to current MSA 30:10:30:30 ratios (Bonny *et al.,* 2017) indicating that the two consumer populations were similar. The cut off scores for better than every day and premium quality, respectively, were slightly lower (37 vs 41) and slightly higher (79 vs 77) than current MSA values, indicating that BeefQ consumers may discriminate more for both unsatisfactory and premium beef. This is important for brands where any inconsistency may impact value. These analyses provide strong evidence that Welsh and English consumers clearly differentiate eating quality from unsatisfactory to premium and that a universal set of sensory weightings and cut off values can adequately define these categories.

Assessment of untrained consumers on eating quality in Zebu and crossbred cattle at aging times

Crossbreeding has been used to improve the sensory quality of Zebu animals (Antonelo *et al.,* 2020), and aging time improves meat tenderness (Perry 2012). The objective of this study was to evaluate the effects of aging times on beef eating quality in Zebu and crossbred cattle. Two experiments are reported in this study. The first one was based on carcasses of Nellore and crossbred (Nellore x Angus) animals at 3 aging times (5, 15 and 25 days) for Longissimus thoracis et lumborum (LD). The second experiment involved 6 muscles from Nellore and Brangus at 2 aging times. Sensory analysis with untrained consumers was conducted with a neighbour-balanced Latin square design (6 × 6) with two block factors, consumer, and assessment order. Consumers rated tenderness, juiciness, and overall liking on a non-structured scale (0-100). The t test was used to evaluate the difference between breeds and aging times in first experiment. A variance analysis was performed for muscle comparison with the post-hoc test including Bonferroni correction for pairwise comparisons. In the first experiment, breed had no effect on sensory traits of the LD muscle. However, beef aged 25 days had on average eating scores 13-20% higher compared to 5-day aged beef. In the second experiment, at 5 days of aging, Brangus cattle presented better scores for all sensory traits (+11-20%). However, increasing ageing time from 5 to 15 days did not improve sensory scores of beef from Brangus. On the opposite, increasing ageing time improved sensory scores of Nellore beef by 11.6-15.4%. At 5 days, muscles showed a difference in tenderness, with the highest grade for rump steak. The striploin improved in flavour and the top Sirloin improved in beef eating quality after 15 days of ageing. As a consequence, there was no more difference between cuts in sensory traits at 15 days of ageing. In conclusion, the crossbred animals need shorter aging time compared to Zebu animals to produce good beef. Increasing aging time in Nellore may be a strategy to improve eating quality of beef.

Loin residual glycogen and free glucose do not affect Australian lamb loin eating quality

Post-slaughter, muscle pH declines through anaerobic metabolism of muscle glycogen to lactic acid. An ideal pH of at least 5.7 is achieved within 24 hours post-mortem when sufficient levels of glycogen are available at slaughter. The inactivation of enzymes that breakdown glycogen occurs as muscle pH lowers, inhibiting further production of lactic acid and thus pH decline, resulting in residual glycogen remaining in muscles (Pethick *et al.,* 1995). During ageing, concentration of free glucose increases from hydrolysis and diffusion of residual glycogen. Both free glucose and residual glycogen may positively affect lamb eating quality through the Maillard reaction during cooking. However, the link between untrained consumer eating quality and residual glycogen has yet to be demonstrated, or whether this association varies between ageing times. Loin samples were collected from 139 lamb (Maternal, Merino, Terminal) and 40 yearling (Merino) carcasses 24 hours post-slaughter and aged for either 5, 14 or 21 days, prior to grilled sensory testing for overall liking by untrained consumers. An additional 5 g sample was collected at each ageing time and assessed for residual glycogen and free glucose. Consumer responses (n=1790) were modelled using ageing time as a fixed effect, and residual glycogen or free glucose tested one at a time as covariates. The unadjusted mean residual glycogen concentration was 14.83, 13.81 and 13.39 µmol/g at 5, 14 and 21 days. Unadjusted mean free glucose was similar across the ageing times ranging from 12.27 at 5 days to 12.22 µmol/g at 21 days ageing. Results showed no association (P>0.05) of loin residual glycogen with loin overall liking scores at any of the ageing times. A similar finding was observed for free glucose on loin overall liking. Despite this lack of effect, further research is warranted to explore the impact of residual glycogen and free glucose on other sensory traits (tenderness, juiciness, flavour liking). Additionally, residual glycogen and free glucose levels vary between muscles due to fibre type and other anatomical differences, and therefore their impact on eating quality within other cuts should be explored.

Combining eating quality and individual cut tracking to maximise value and decrease waste in beef

Typically, processors are limited to how many ways cattle can be sorted as they come into the boning room. In most cases, individual identification is lost as cuts fall onto the belt. This affects the ability to maximise individual carcass value and often results in better quality carcasses or cuts being downgraded because of their pre-assigned batch. Yield based measurement systems are becoming popular in processing facilities. These systems can individually identify and track cuts, whilst collecting multiple yield measurements along the boning line, enabling processors to segregate product of consistent weight and size into specific brands. Eating quality is an important value for calculating consumer satisfaction across multi-cuts, cook types and days ageing on varying cattle populations. Produced from the International Meat Research 3G Foundation 3G Grading Model (Hocquette *et al.,* 2020), an eating quality matrix provides processors with the ability to differentiate their product into trusted brands based on EQ cut off scores (Pethick *et al.,* 2021). By facilitating an accurate interpretation of eating quality matrix produced by the 3G grading model, and aligning this into a cut tracking system combined with yield results, it enables individual cut sorting to happen in real-time at chain speed. This system would eliminate the need for extensive pre-sorting of carcasses, decrease capture losses and generate increased carcass value through the uplifting of cuts into better valued brands. Using Birkenwood's MEQ Toolkit and Marel's StreamLine system, a case study on generic data reported on the potential benefit of this system over a 3-month period. The processor was previously using basic cut offs for its brands across a small number of cuts. The analysis only looked at the system improving what was currently in place at the processor. Results from the case study revealed a large increase in product capture into the top brand (average 82.5%, range 28-175%) and increased the average €/Hd across the entire dataset from 597 to 733 Euros.. Potential value and cut capture would only increase if expanded to look at multi-cuts.

II. PREDICTION OF LEAN MEAT YIELD AND EATING QUALITY TRAITS FOR CARCASE GRADING

Changing the Australian trading language for beef and lamb to adapt to new measurement technologies

Since 2016 an Australian project (ALMTech) has accelerated the development and implementation of technologies that predict traits describing eating quality and saleable meat yield %. Initially these technologies were trained to predict traits that are commercially traded upon within industry. However, it soon became apparent that the existing industry trading language was limiting, as evidenced by the following 3 scenarios.

The first is an example of where technologies can measure a trait that was not legislated for trading. In this case we introduced intramuscular fat % (IMF%) into the lamb industry trading language – a crucial step given the importance of this trait for predicting eating quality (Stewart *et al.*, 2020). This was underpinned by a Soxhlet laboratory method as the gold standard. In the second scenario, we introduced an alternative trait for one that poorly describes carcase value. In this case GR tissue depth in lamb was the historical measurement used to reflect saleable meat yield %. We introduced the alternative whole carcase lean % as a better indicator of saleable meat yield %, using computed tomography as the gold standard measurement. In the third scenario we provided an alternative to an existing trait that performed poorly as a calibrating standard for technologies. In this case we introduced IMF% into the beef industry to

act in parallel with visual marble scores which have proven too erroneous for accrediting technologies. Conversion equations have also been established enabling these values to be interchanged. These new traits calibrated against robust gold standards have delivered multiple benefits. Firstly, technology provider-companies were instilled with the confidence to commercialise due to the provision of achievable accreditation standards. Secondly, processors had the confidence to invest in these technologies and establish payment grids based upon their measurements, knowing that reliable accuracy standards had been met. And lastly, data flow into genetic databases, industry data systems (MSA), and as feedback to producers was enhanced because of these technologies.

The precision and accuracy of the Q-FOM grading camera predicting rib eye traits in beef carcasses

The Q-FOM^{TM} Beef (Frontmatec Smoerum A/S) camera is a non-contact, rechargeable device specifically designed for ribeye grading according to AUS-MEAT and MSA grading standards, either in the chiller or at a grading station. The Q-FOM is able to grade in real-time MSA and AUS-MEAT marble score, AUS-MEAT eye muscle (EMA), AUS-MEAT meat colour, AUS-MEAT fat colour, MSA sub-cutaneous rib fat and chemical intramuscular fat (IMF%). A total of 4677 commercial carcasses from two Queensland export abattoirs were quartered between the 10th and 13th rib for grading and imaged using 3 cameras. A diverse range of carcass categories (Wagyu, grain fed (long, medium, short), organic, grass-fed, dairy, cull cow) were targeted to achieve a broad phenotypic range in rib eye traits. Visual ribeye grading was performed by two MSA expert graders and one commercial grader according to the AUS-MEAT chiller assessment language guidelines (AUS-MEAT, 2005) and used as reference. Precision (R2, RMSEC/RMSEP) and accuracy (bias) were reported for both calibration and validation analyses for EMA (R2 = 0.95; RMSEP = 3.5; slope = 0.98; bias = 1.6) and MSA marbling (R2 = 0.95; RMSEP = 63.7; slope = 0.9; bias = -33.6). The performance of the camera against the Australian Meat Industry Language and Standards Committee (AMILSC) accreditation standards (AUS-MEAT, 2022) were reported for EMA, MSA and AUS-MEAT marbling, Fat and Meat colour. In addition, a high level of repeatability and reproducibility of Q-FOM Beef cameras was demonstrated across all traits.

Predicting IMF% and visual marbling scores on beef portion steaks with a Marel vision scanner system

Marbling score is an important factor in many beef carcass grading schemes to classify carcass quality grades. Under the current Meat Standards Australia (MSA) and AUS-MEAT grading system, marbling score is visually assessed by accredited graders on the caudal surface of the m. longissimus thoracis et lumborum (loin) at a rib site between the 5th and 13th rib. The marbling score assessed at the grading site, is assumed to adequately represent the entire loin. Contrary to this assumption some studies have indicated that marbling varies within the beef loin. Therefore, the grading of individual steaks could enhance classification of marbling grades for individual portions and could underpin an enhanced marbling specification for portion-cut product entering premium markets. This study describes the performance of a Marel conveyer vision scanner system in its ability to predict MSA and AUS-MEAT marbling scores of portion steaks from the cube roll. The capacity to predict the new AUS-MEAT trait of IMF% that has been approved as the gold-standard-trait for accreditation of objective measurement technologies was also assessed. Vision scanner marbling scores were acquired on fresh-cut steaks of beef carcasses (n = 102) that represented a wide range in visual marbling score. The vision scanner predictions were tested using a leave-one-out cross validation method, which demonstrated precise and accurate predictions of IMF% (R2 = 0.87; RMSEP = 1.16; slope = 0.09; bias = 0.22), MSA (R2 = 0.82; RMSEP = 70.11; slope = 0.09; bias = 17.08) and AUS-MEAT marbling (R2 = 0.79; RMSEP = 0.75; slope = 0.16; bias = 0.08) (Pannier *et al.,* 2023a).The Marel vision scanner prediction of visual grader scores was relatively less precise and accurate than its prediction of IMF%, likely due to random error in subjective grader scores. Furthermore, variation observed for the Marel vision scanner marbling scores across the length of the cube roll indicated that marbling at the grading site does not entirely represent marbling variation throughout the entire primal (Pannier *et al.*, 2023b). This marbling variation when expressed in units of MSA marbling score, equated to 316 MSA units, which would impact the eating quality prediction within the MSA model (Pannier *et al.*, 2023b). These results indicate that the Marel Vision Scanner could be used to underpin a market for premium portion-cut steaks where enhanced product description and consistency is required.

Improved analysis of dual energy x-ray absorptiometry images enhances lamb eating quality prediction

Dual energy x-ray absorptiometry (DEXA) is used in commercial abattoirs in Australia to predict carcass composition (Gardner *et al.,* 2018). Images captured using DEXA are at two different energy levels, with the pixels captured at low energy expressed as a ratio (R value) to those captured at a high energy, and relate to the atomic mass of the tissue. The mean R values from DEXA images have previously been used to predict lamb eating quality using isolated bone regions from the images (Anderson *et al*., 2021), however this was in a small number of lambs and also demonstrated correlation with intramuscular fat content. Improvements in image analysis have enabled better isolation of the entire lamb skeleton, enabling calculation of the mean bone DEXA R value. This technique has been applied to a larger dataset from 2 abattoirs for lambs that varied in age/maturity (n = 198). As the bone DEXA R value increased there was a decrease in the eating quality of some cuts, as evaluated by untrained consumers on a scale from 0 to 100. The relationship between bone DEXA R and eating quality was most consistent in the loin grill where overall liking scores decreased by 10 units ($P < 0.05$) at both abattoirs. This

relationship was independent of loin intramuscular fat % and carcass lean %, which were tested simultaneously in models alongside bone DEXA R values. Similar associations were also found in other cuts, although the magnitude of effect varied. The improvements to DEXA image analysis enable chain speed DEXA scanning of lamb carcasses to rapidly predict aspects of lamb eating quality. Given the large proportion of the Australian lambs that undergo DEXA scanning at slaughter (≈50%), this represents the ability to provide information on a large proportion of the lambs processed in this country. DEXA eating quality predictions may be incorporated alongside other production traits and carcass measures that could better allow for in-plant carcass sorting and recognition of carcass quality on which to base payment.

Aligning upper and lower commercial beef DEXA images to predict CT composition

The Australian beef industry is focused on improved measurement of beef carcase composition and valuation along the supply chain. An initial study demonstrated that a prototype rapid dual energy X-ray absorptiometry (DEXA) can predict the computed tomography (CT) composition of entire beef carcases with excellent precision and accuracy (Calnan *et al.*, 2021), which led to the installation of the first commercial beef DEXA system in Rockhampton Australia to measure CT composition in chilled beef sides scanned at line speed. The system is comprised of two DEXA units positioned vertically that scan the entire length of hanging beef sides to produce upper and lower images that overlap centrally. For established DEXA CT prediction equations (Calnan *et al.*, 2021) to be aligned with and outputted by this commercial DEXA system, an automated method of stitching the beef DEXA images is needed that accounts for the duplicated central section and thereby maintains a consistent measure of whole side composition. Two approaches were explored to achieve this; 1) using an anatomical landmark and 2) based on the number of duplicated pixel rows in carcase DEXA images. The caudal aspect of the 13th rib was identified as an anatomical landmark in the overlapping section of both DEXA images that could guide image stitching. An advantage of this method is that upper and lower DEXA images become a good approximation of the carcase 'forequarter' (lower image) and 'hindquarter' (upper image).

However, difficulties were encountered in the ability of an operator to consistently identify the 13th rib landmark in both upper and lower DEXA images, making this method inconsistent and unreliable. Alternatively, the number of pixel rows duplicated in upper and lower DEXA images was determined using scans of plastic calibration blocks, the scanning of which have been crucial in the commercialisation and accreditation of on-line DEXA systems in the Australia lamb industry. This method of image stitching is advantageous in that it can be consistently applied to beef DEXA images regardless of carcase size or length and can be easily automated. This method has therefore been adopted to produce a single DEXA value for each beef side for use in pre-existing DEXA CT prediction algorithms to output an estimate of carcase CT composition. However direct calibration of this commercial DEXA system against CT measures of beef composition will be undertaken and will provide an opportunity to further refine this image stitching method.

Calibration of chain-speed DXA units using synthetic phantom blocks in two Australian lamb abattoirs

Dual Energy X-ray Absorptiometry (DXA) technology has been developed for chain-speed predictions of carcass composition in Australian lamb abattoirs, capable of predicting fat %, lean muscle % and bone % with high precision and accuracy (Gardner *et al.*, 2018). With multiple DXA units in operation across the country, a simple yet reliable method of calibrating them against one another was required. A synthetic phantom constructed of three different plastics (acrylic, high molecular weight polyethylene, and nylon) of varying mixtures and thicknesses is installed at each DXA site and is scanned at the commencement of every production day. The thickness of the plastic sections, as determined by the individual DXA, is compared to the thicknesses at one DXA site in Western Australia operating as the reference. Similarly, the predicted fat % composition of each plastic block is compared to that from the reference site, generating a calibration curve for the R-values of the DXA images. The thickness and R-value differences between the test site and the reference site are applied to all pixels in the DXA image through linear transformations, allowing the test site to calculate the carcass composition using the same algorithm as that applied at the reference site. The predictions of carcass composition can be validated against the computed tomography (CT) determination of fat, muscle, and bone %. The application of this cross-site calibration resulted in an increased precision for the prediction of CT fat % (R2=0.92, RMSE=1.45%) from the uncalibrated values (R2=0.89, RMSE=1.81%), while the accuracy was also increased (slope=1.06, bias=-0.49%) from the uncalibrated values (slope=0.59, bias=25.5%). This calibrated precision of CT fat % prediction was well aligned with the precision at the reference site (R2=0.93, RMSE=1.39%), as was the accuracy (slope=1.26, bias=-1.17%). This method of calibration is suitable for calibration of DXA systems between abattoirs, as it is quickly calculated and applied, and enables DXA to be accredited for trading across Australia.

III. INCORPORATION OF CARCASE GRADING INTO GENETIC EVALUATION PLATFORMS

Objective carcase measurement from commercial supply chains contributing to genetic improvement

Australia's meat supply-chains are investing in a range of new technologies to improve productivity across the whole value-chain. This has been a collaborative effort aiming to transform industry competitiveness by creating feedback and decision support systems linked to accurate carcase measurements. The Australian sheep industry has also been developing tools for sheep breeders to make simultaneous improvements in the proportion of carcase saleable meat (lean meat yield: LMY) and its eating quality (EQ) (Guy and Brown, 2019). Lean meat yield and eating quality attributes are antagonistically related and 'difficult to measure' for seedstock selection purposes. Objective carcase measurements from commercial supply chains offer an important tool for seedstock breeders, and the genetic validation of new technologies for assessment of LMY and EQ can increase opportunities to improve genetic progress. Genetic analysis of both LMY and EQ traits, recorded using several new technologies, demonstrated excellent accuracy. This analysis provided the platform for the new measures to be used in routine genetic evaluation and fast-track genetic progress (Swan *et al.*, 2018). Furthermore, our existing genomic selection protocols coupled with objective carcase measurements from commercial lambs offer new opportunities to increase the reference population size and reduce the current reliance on expensive resource populations. New LMY and EQ measuring technologies can also help seedstock breeders by using the collected data and developing platforms to underpin pricing signals for commercial sheep producers. Currently there are limited pricing signals for both LMY and EQ but their development can help seedstock breeders to invest in these traits within their breeding objectives.

CONCLUSION

This session presented results clearly showing that it is possible to develop commercial grading systems in all collaborating countries that can predict the eating quality score that corresponds to different price points which consumers are prepared to pay depending on the level of quality. The final goal is to better meet consumer expectations and increase the financial return to the abattoirs and livestock farmers. The measurement of lean meat yield has for many years been part of grading systems world-wide. However, the precision of the measurements has been low, typically due to point measures of fatness or the subjective nature of fat, muscle and conformation measures. Indeed, even measures associated with eating quality such as marbling are still undertaken by trained human graders and consequently there is the potential for human error and grader biases. These issues were addressed by the introduction of X-ray based DEXA technologies for the precise measurement of lean meat yield in lamb and beef. Also, the recent development of a commercially available handheld camera (Q-FOM^{TM} Beef) for beef carcass ribeye grading was presented. The importance of appropriate statistically underpinned industry standards was presented with the suggestion that the estimation of marbling should be based on the prediction of chemically measured intramuscular fat rather than human based visual grading. Finally, an example of progress toward utilising accurate carcase grading traits (i.e. lean meat yield, intramuscular fat) to routinely underpin commercial genetic evaluation programmes was discussed.

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