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The prediction of carcass composition and tissue distribution in beef cattle using ultrasound scanning at the start and/or end of the finishing period

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ABSTRACT

Ultrasound tissue depths, similar to those measured commercially as part of UK beef genetic evaluation schemes, were measured on 52 crossbred steers and 10 heifers at the start and end of the finishing period (average age 476 and 568 days, respectively). Animals were slaughtered at commercial target weights and carcass grades, and one carcass side fully dissected. Combining live weights and ultrasound tissue depths measured both before and after finishing provided the best predictions of carcass composition. Dissected fat weights and proportions in the carcass side, the forequarter and the hindquarter were predicted with high accuracy (R^2 ~ 0.8), muscle weights with moderate accuracy (R^2 = 0.5–0.6), but muscle proportions were less accurately predicted (R^2 = 0.23–0.49). Meat and Livestock Commission (EUROP) carcass conformation and fatness classes could also be predicted with moderate accuracy (R^2 = 0.4 and 0.6, respectively). Fat and muscle weights in each quarter expressed as proportions of the total weight of that tissue in the carcass side were not predicted accurately (R^2 < 0.4). Live weight and ultrasound data measured only at the start of finishing also gave good predictions of fat proportions in the carcass side and quarters (R^2 = 0.64–0.67), and moderate predictions of fat and muscle weights and fatness class (R^2 = 0.38–0.53), but low prediction accuracies for muscle proportions and conformation classes. In comparison, live weights and tissue depths measured only at the end of finishing explained 12 to 19% more of the variation in fat weights and fatness class, but predicted muscle weight, conformation class and fat proportions with similar accuracies and muscle proportions with similar or less accuracy. Including ultrasound fat depths, alongside muscle depth and live weight, in equations to predict muscle weights and proportions increased prediction accuracies to similar values as those estimated for fat traits, but increased confounding between predictions of different tissues.

Derived prediction equations were validated on data from another 32 heifers and 48 steers, relating ultrasound-predicted weights to carcass tissue weights predicted from fore-rib sample joint dissections. Prediction accuracies (R^2) of between 0.52 and 0.64 were achieved for fat and muscle weights and fat proportion in the carcass side, when the model included post-finishing measurements, but were lower (0.29–0.52) using only pre-finishing measurements. Predictions of muscle proportions and conformation classes were of poor accuracy, regardless of the model used.

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1. Introduction

In the UK, Signet Breeding Services (http://www.signetfbc.co.uk/) and the Agricultural Business Research Institute (ABRI), are responsible for delivering breeding evaluations to the beef sector. As part of the 'Beefbreeder' national pedigree beef

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evaluation scheme, run by Signet, technicians take on-farm measurements of ultrasonic muscle and fat depths, which are used to produce estimated breeding values (EBVs) for these traits and also contribute towards a "Beef Value" (Amer et al., 1998). Animals are ultrasound scanned between 350 and 500 days of age and measurements include fat depths over the 3rd lumbar vertebra and the 13th rib, as well as muscle depth measured over the 3rd lumbar vertebra (http://www.signetfbc.co.uk/ beefbreeder/members/record_protocols.htm).

Previous studies have considered the potential of measuring live weight and ultrasound predictors of composition of cattle at the beginning of the finishing period, to allocate feeding groups and levels (Williams, 2002), or for early selection of potential breeding stock, and pre-slaughter, to provide accurate estimates of carcass composition for sorting carcasses on quality (Greiner et al., 2003; Tait et al., 2005). In breeding programmes, the best predictors of carcass composition are required to accurately select breeding stock, preferably at a young age to reduce generation interval.

The weights and proportions of different tissues (fat, muscle and bone) in the carcass, and the distribution of tissues throughout the carcass, are of high economic importance. For example, the hindquarter is comprised of more valuable cuts of meat than the forequarter (Jarrige and Auriol, 1992). Many previous studies have concentrated on the ability of ultrasound to predict fat depth at the 12th rib and loin muscle area (May et al., 2000). Some have also considered the ability of ultrasound to predict total yield of lean meat or retail product in a carcass side (Bergen et al., 2005; Realini et al., 2001), weight of sub-primal cuts (Indurain et al., 2009), fat trim (Realini et al., 2001) and percentage of retail yield in primal and sub-primal cuts (Greiner et al., 2003; Tait et al., 2005). For example, using regressions including live weight, loin muscle area and fat depth measured by ultrasound, Tarouco et al. (2007) derived accurate predictions of weight of retail product in the hindquarter ($R^2 = 0.78$), although predictions of percentage of retail product in the hindquarter were less promising ($R^2 = 0.18$). Fewer studies have used beef ultrasound measurements to predict absolute weights of dissected fat and muscle in the carcass side.

Bergen et al. (2005) considered several methods and previously-published prediction equations for predicting total lean meat yield in a carcass side using ultrasound. These authors found similar accuracies using ultrasound muscle depths and widths in prediction equations as they did when using loin muscle area and fat depths. Accuracies of lean meat yield predictions across all methods were around 55–75%. Ultrasound is noted to be more accurate in prediction of linear measures (fat thickness or muscle depth) than areas (Realini et al., 2001). Muscle area accuracy and repeatability are more dependent on equipment, technician and experience (Herring et al., 1994; Hassen et al., 1998).

It is also of importance to be able to predict carcass fat content, both in terms of absolute weight and as a proportion of the carcass. These traits are important for economic efficiency of production, human health and to help in reducing waste as trimmed fat.

The objectives of this study were to investigate: (1) the ability of ultrasound-measured fat and muscle depths to predict carcass composition and tissue distribution; (2) the relative accuracy of predicting composition from ultrasound measurement taken at the start or end of the finishing period.

2. Materials and methods

2.1. Live animals

Aberdeen Angus and Limousin sires were used on a crossbred suckler cow herd, run at SAC Edinburgh, as part of a two-way rotational crossing system, which had been managed under commercial conditions for several years. All procedures involving animals were approved by the SAC Animal Ethics Committee.

In year 1 of this study, 15 steers sired by one Aberdeen Angus bull (AAX) and 29 steers sired by one Limousin bull (LIMX) were grazed as a single group from mid-May (at around 13 months of age) until late July, when they were housed for the experimental finishing phase (average age 482 days, average live weight 499 kg). Steers were fed a commercial *ad libitum* diet comprising grass silage and a cereal-based concentrate. The animals were finished in three batches for slaughter, within a 42 day period, and were selected for these batches based on live weight (LWT) and subjective visual appraisal of fatness and conformation, with the aim of slaughtering at a target of R4L on the Meat and Livestock Commission (EUROP) carcass classification scale (average age 576 days, average LWT 618 kg).

In year 2, 100 animals were finished in a similar way to the previous year. These animals were either AAX (from 3 sires) or LIMX (from 4 sires) and both steers ($n = 58$) and heifers ($n = 42$) were studied in this year. Animals were slaughtered in 5 batches in the second year, within a 56 day period (average age 544 days, average LWT 596 kg).

2.2. Ultrasound scanning

Ultrasound scanning (Dynamic Imaging Concept C/MLV with 13 cm 3.5 MHz probe, P3VLR) was performed on the left side of all animals in each year at the start of the finishing period and pre-slaughter (the day before slaughter for each batch) by the same experienced technician on behalf of Signet Farm Business Consultancy. Standard commercial measurements were taken at each of the two time points, which included one muscle depth measurement (UMD) over the 3rd lumbar vertebra (LV3) and eight individual fat depth measurements (UFD) — four over the LV3 (the first above and dorsal to the acorn then laterally at 2 cm distances from this point; UFL_1 to UFL_4), and four in a similar way over the 13th rib (UFT_1 to UFT_4). The four measurements at each anatomical position were also averaged (UFL_AV, UFT_AV). LWT was measured at the time of ultrasound scanning, at the start and end of the finishing period.

2.3. Carcass measurements

Approximately 1 h post-slaughter, following dressing of the carcass, weights of each carcass side were taken using an in-line rolling scale, to provide a measure of total hot carcass weight (HCWT) and left side weight (SDWT). Based on the EUROP classification system, Meat and Livestock Commission classes for conformation (MLCC) and fatness (MLCF) were awarded to each carcass, which were transformed to numerical values (SEERAD, 2004). Fatness classes were transformed to approximately estimate subcutaneous fat percentage multiplied by ten (1 = 20, 2 = 45, 3 = 65,

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