Results for today; Ideas for tomorrow

Meat Technology Update

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Understanding meat yield

Meat yield means different things to different sectors of the meat industry. Researchers often talk about the yield of dissectible muscle (usually referred to as percentage lean meat). On the other hand suppliers of carcase meat to the domestic and export markets are most interested in the yield of saleable meat from each carcase. Exporters of bulk-packed meat for manufacturing specify the percentage of chemical lean. Due to the variety of interpretations, there continues to be confusion about what is yield.

Lean meat percent (LM) or chemical lean percent (CL) are easily standardised in terms of fat content, and can therefore be estimated accurately, making them widely used by the research fraternity. Often the meat industry needs a definition that is more commercially recognisable such as saleable meat yield (SMY). SMY is more difficult to specify or predict than LM or CL because there are numerous market specifications, particularly in relation to the degree of fat trimming required.

Definition of yield

For the purpose of this article the following definitions are used:

Lean meat percent (LM) – Weight of muscle tissue that has been trimmed free of visible fat, expressed as a percentage of cold carcase weight.

Chemical lean percent (CL) – Lean meat content as determined by chemical analysis (i.e. 100-chemical fat content).

Saleable meat yield percent (SMY) – Yield of bone-in or boneless cuts plus manufacturing meat that have been trimmed to a desired fat coverage or level and expressed as % of cold carcase weight.

Carcase composition and yield

Among carcases of similar weight, the proportions of the

various carcase components (i.e. muscle, fat and bone) vary considerably depending on breed type and growth rate. The proportion of muscle in the carcase is of major importance since this is the prime determinant of yield and commercial value. The ratio of fat to muscle is probably the single most important criterion by which consumers judge the quality and value for money.

There are three important factors when considering saleable meat yield: fat thickness; carcase weight; muscle-to-bone ratio.

Fat thickness

Fat is the most variable carcase component both in its amount and distribution. The three primary carcase components; muscle, bone and fat, each grow at different rates. Once the animal reaches its mature weight, muscle and bone growth taper off but the

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deposition of fat continues.

It is possible to indirectly estimate the proportion of muscle in a carcase by estimating its overall fatness. The measurement of fat depth has, as a consequence, become an important component of carcase classification schemes for beef, sheep and pork carcases, worldwide.

There are major fat depots within the carcase. The first to be deposited is the internal fat (kidney and channel fat), which represents about 4% of the carcase weight. The 'intermediate' sites of deposition are beneath the skin (subcutaneous fat) and between the muscles (intermuscular fat). The remaining site of fat deposition is within the muscle (marbling). Marbling was thought to develop at a later age but this has recently been refuted. Fat deposition occurs simultaneously within the depots but at different rates depending on the age of the animal.

Carcase weight

Carcase weight has a major influence, not only on the quantity of the various tissues, but also on the size of the individual muscles within the primal cuts. carcase weight is important, as the relationship between carcase weight and fatness varies between breeds and also between grass and grain-fed animals. Furthermore, the individual weights of various muscles and primal cuts are highly related to the total weight of the carcase so an understanding of this relationship is important when attempting to meet market specifications with regard to primal-cut weight.

Muscle-to-bone ratio

After accounting for weight and fatness, the remaining variation in carcase composition in mixed breed populations is largely explained by differences in muscle: bone ratio. It is an important characteristic of any carcase in determining its ultimate value and, clearly, the higher the muscle:bone ratio, the better the yield. The muscle:bone ratio changes during growth and plateaus near its maximum value (around 5.1, 4.8 and 4.9 for bulls, steers and heifers, respectively) when animals reach about 50% of their mature weight. If animals are slaughtered beyond 50% maturity, there is little need to consider growth changes in this ratio. However, if an animal is slaughtered earlier than this, when its overall weight and proportion of muscle are both increasing, the weight of saleable meat and, therefore, the value of the carcase, will increase appreciably after small time intervals (i.e. weeks). While this has remained an important criterion when assessing yield, the accurate estimation of the muscle:bone ratio by means other than complete dissection of the carcase into component parts, has remained elusive. Subjective assessments of muscle score (i.e. degree of muscling) have been used with varying degrees of success in live animal and carcase-classification systems as a proxy for muscle:bone ratio; however, such scores are still constrained by the vagaries of subjective assessment.

Production factors that influence yield

Carcase composition can be controlled, within limits, by modifying the factors that influence the growth of different tissues. Muscle is the most desired tissue, bone is the least desired and fat is desired in different amounts by different markets and consumers.

The production variables that control fatness are breed, live weight (and maturity) at slaughter, sex, and nutrition. Growth promotants are a recent short-term method for controlling fatness. They are used in approximately 90% of US lot-fed cattle and reasonably widely throughout Australia. The most important determinant producers will use when deciding how to manipulate carcase fatness will always be economic. The returns for producing leaner stock must be financially worthwhile to both producers and processors for it to occur.

Breed

The genotype of the animal determines the potential for it to develop particular carcase characteristics and meat quality. Genetic differences in yield and fatness traits have been observed between breeds and between strains within breeds.

No single cattle breed has all the attributes that are needed to produce beef efficiently in all environments, and to meet the requirements of all markets. The appropriate use of systematic crossbreeding programs provides significant benefits to the beef industry in terms of both yield and meat quality. Similar programs benefit the sheepmeat industry.

Carcase composition traits such as fat thickness and carcase weight are moderately to highly heritable and breeding programs respond well to genetic selection. Most estimates of beef and sheepmeat yield percentage are also moderately to highly heritable. Therefore, producers can exploit the genetic variation that exists to make rapid genetic gains in saleable meat yield.

The table below indicates the results for carcase attributes from purebred steers produced in the Germplasm Utilisation Program at the US Meat Animal Research Center, Clay Center, Nebraska.

Breed	Carcase wt (kg)	Fat depth* (mm)	Fat trim (%)	SMY (%)
British				
Red Poll	315	7.62	22.4	62.6
Hereford	306	11.68	25.5	60.1
Angus	316	11.68	24.4	61.5
European				
Limousin	330	4.32	13.4	72.3
Simmental	348	4.06	15.5	68.4
Charolais	348	3.56	15.0	68.7

* Fat thickness 12/13th rib (Adapted from Cundiff and Gregory, 1999)

European breeds excelled in saleable meat yield but had difficulty grading USDA Choice because of lower levels of marbling. British breeds excelled in USDA carcase-quality grade but had excessive fat thickness and percentage fat trim and reduced saleable meat yields.

Maturity

Maturity is defined as the live weight of the animal where muscle and bone growth tapers off and fat deposition increases. The rate at which an animal matures has a major influence on its composition at a given weight or age. Early-maturing types such as British breeds yield less lean meat at a given weight and age than, say, Brahman crossbreds. Animals can be slaughtered at the appropriate live weight (and level of maturity) for a particular breed and sex as a means of controlling the level of fatness to that required for a target market. For example, Hereford cattle would be slaughtered at an earlier age than Brahman crossbreds. The alternative, and considerably more costly, strategy is to produce heavier, fatter animals and trim the meat back to the level of fatness required by the marketplace.

Sex

Sex has a marked effect on the deposition of fat. Females mature at lighter weights than castrates or entire males. Under similar feeding conditions, mature females will be fatter than castrate males, and castrates are fatter than entire males at a given weight. Therefore, females are slaughtered at lighter weights, otherwise excess fat will have to be trimmed from the carcase.

Nutrition

Different components of diets can influence carcase fatness to varying extents. In general, a fast-grown animal will be fatter than its slower-grown counterpart. This is because at any stage of growth there is some maximal rate of muscle growth, which appears to be related to age as well as protein intake. Additional energy intake above maintenance is partitioned towards fat gain. The faster growing animal will also tend to have proportionally more of its carcase fat as subcutaneous fat. It is important to recognise that where grading systems use a measure of subcutaneous fatness to determine the value of a carcase, those from fatter, faster-grown animals are more likely to be downgraded than if the carcase weight alone is the major or sole criterion of value.

When feed supply is restricted in the finishing phase to below ad libitum, the rate of fat deposition decreases but the rate of lean deposition is maintained. As a result, animals on a restricted diet have lower proportions of fat and higher proportions of lean than unrestricted animals at the same weight. However, the effect on fat deposition, due to restriction, decreases as the animal approaches maturity. In this instance, the length of time and severity of restriction need to be greater for there to be a noticeable effect.

Growth promotants have been developed to provide a cost-effective way of manipulating growth and carcase composition in order to fulfill the increasing need for more rapid turnoff and higher yields. In general they improve live weight gain, feed efficiency and LM of meat-producing animals. It should be noted that growth promotants have a more variable (i.e. less predictable) effect on carcase fat than they do on live weight.

Processing factors that influence yield

Weight loss at various stages of processing probably leads to most of the loss of potential yield. Weight losses can occur during the pre-slaughter phase, during chilling, transportation and retail display, from vacuum packs (as weep), and during frozen storage. These factors will be discussed in a future article.

The inability of boning-room staff to trim primal cuts consistently to the desired specification contributes to variation in yield. They require information on each carcase in order to make informed decisions on how best to utilise it.

Yield estimation

Calculations of the yield of a particular carcase or group of carcases can be done from a systematic series of weights: hot carcase weight; cold carcase weight; weight of individual primals trimmed to specification for the particular market; and weight of trimmings. Comparison of the cold-carcase weight with the hot-carcase weight provides a measure of the weight lost during chilling. Yields of saleable meat can be calculated for individual primals, or groups of primals, or the aggregate of primals and trimmings. Indicative weight ranges and yields for various beef and sheepmeat cuts are available in the AUS-MEAT, Australian Handbook of Australian Meat. Whilst this approach provides very reliable information, it is very labour-intensive and can only provide information once the carcases have been broken down. It is impractical for routine use in commercial boning rooms.

The widespread use of fat depth as a predictor has already been mentioned. Techniques are now available that can be used to predict saleable beef yield and overall suitability of carcases for specific markets. Considerable effort has been devoted to investigating alternative methods and technologies to predict carcase yield and carcase composition. From the vast array of approaches the two most commercially viable options are discussed below.

Carcase assessment

The combination of carcase weight and measurements of fat coverage and depth have been reliably applied in commercial practice to predict carcase yield and composition. The addition of eye muscle area with this combination can improve the predictive accuracy, at least for some market categories.

The carcase weight is available in practical circumstances at negligible cost and is therefore used in most models of yield prediction. The subcutaneous fat thickness of beef carcases is usually measured at the P8 site but is occasionally measured in the loin or rib regions. This measurement is commonly taken in Australia using the simple cut-and-measure knife or alternatively by the more sophisticated Hennessy Grading Probe. For sheep and lamb carcases, fat thickness can be measured using a GR knife or with the AUS-MEAT Sheep Probe. Eye muscle area is usually measured on the loin cross-section on the quartered side. This

may be measured manually or electronically by placing a plastic grid on the muscle surface.

Video image analysis (VIA)

VIAscan® is an electronic imaging technique developed in Australia to assess meat quality and saleable meat yield for beef sides and quarters, and sheep carcases. Systems have been developed to assess carcase-quality attributes and saleable meat yield. The first system, the VIAscan® Beef Carcase System (BCS), provides carcase dimensions and objective colour measurements that are calculated from a video image taken on-line on the slaughter floor which predicts saleable meat yield. Colour analysis gives fat and lean colour, and bruising. These performance measurements allow for better carcase sorting and timely scheduling of boning activities.

A second system, the VIAscan® Chiller Assessment System (or ribeye camera), objectively measures ribeye area and shape, marbling, fat thickness, and lean and fat colour on quartered beef sides. The system is accredited by AUS-MEAT to report Chiller Assessment parameters. Measurements from this system complement those taken from the BCS to provide more robust predictions of yield across the commercial range of beef carcases. Whether utilized independently or in tandem, the VIA systems provide accurate and consistent data regarding the yield and quality of beef carcases. They provide information on the suitability of a particular carcase for any of a range of markets.

The Sheep Carcase System has also been trialed extensively in Australia and New Zealand and is now used commercially. It also provides predictions of carcase lean meat yield at line speeds and is accredited by AUS-MEAT to report AUS-MEAT GR Fat Score.

Future prospects

Most consumers now demand more lean and less fat in the meat they purchase. If processors and retailers have to trim off fat equivalent to, say, 5% of the weight of saleable meat, their yields are correspondingly reduced. As a result there is now a general recognition of the need to reduce the average fat content on beef and sheep carcases. A good understanding of why some animals yield better than others, and access to cost-effective, practical and accurate technologies in determining carcase composition, are essential to the meat industry in the future. It is inevitable that there will be wider adoption of procedures that make it possible to differentiate carcases according to quality attributes for particular markets. The challenge for the meat industry is to be able to maximise yields for each of these markets.

Key points

- Saleable meat yield (SMY) of cattle varies by more than 10%.
- Fat is the most variable carcase component.
- Breed, age at slaughter, nutrition, and sex have great influence. Processing factors also affect SMY.
- Reliable measurements of fat thickness and distribution are needed for predictions of SMY.
- Objective carcase assessment, eg. VIA, give reliable predictions of yield and quality.

For more information, contact one of the Meat Industry Services staff listed below.

Food Science Australia Meat Industry Services Section

The Meat Industry Services (MIS) Section of Food Science Australia is an initiative supported by Meat and Livestock Australia (MLA) and the Australian Meat Processor Corporation (AMPC) to facilitate market access for, and support world-class practices in, Australia 's meat industry.

Need additional information help, information or advice? Contact any of the following

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