# Effects of grain feeding on carcase composition and eating quality

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## Introduction

In Australia, finishing cattle in a feedlot has evolved to achieve specific carcase weight, fat, marbling and fat colour endpoints at younger ages, as well as serving as a safeguard against adverse seasonal/pasture conditions. Feeding cattle an adequate energy dense diet results in faster growing cattle which achieve their designated market weight at a younger age with, usually, a greater amount of fat, including intramuscular (marbling) fat.

This paper will provide an overview of the effect grain feeding, faster growth rate, younger age and increased fatness has on carcase yield and the final eating quality of the beef produced. Results from the CRC and MSA programs will be used to illustrate some of these effects.

## Feedlotting and carcase yield

As differences in carcase yield due to feedlot versus pasture finishing may be due to difference in growth rate, this section looks first at the effect of diet, and then at the effect of diet, when adjusted for difference in growth rate.

### *Nutrition – Feedlot v pasture*

- Tudor (1992) reported that feedlot animals deposited more fat (3.5%) and less protein than pasture fed cattle at the same carcase weight and growth rate, whilst Priyanto et al (1992) found that grain fed animals had more fat (4%) and less muscle (2.5%) than pasture fed animals, at the same fat depth.
- Priyanto et al (1993) reported that, as fat depth increased, the increase in total fat deposited was greater in feedlot than in pasture finished animals, and the decrease in yield was also greater, with the yield of feedlot animals declining by 4.6 % for each increase of 1mm in fat depth, compared with a decrease of 2.3% in pasture finished animals.
- At the same market endpoint and fat depth, grain fed animals in the CRC had at least 2% less retail beef yield (RBY%) than pasture finished animals, with the difference being as large as 3.3% for tropically adapted breeds finished in NSW (Perry et al. 1999).

This suggests that the deposition of fat in feedlot and pasture finished animals differs, with proportionally more fat being laid down in the intermuscular depot and/or less in the loin region in feedlot compared to pasture finished animals.

### *Growth rate*

The effect of growth path on yield and meat quality is not a simple question. Overall growth rate from birth to slaughter will not necessarily be representative of growth rates

and set backs during distinct periods of an animal's growth path, such as during the periods of pre- and post-weaning, backgrounding and finishing. Any effect of growth rate during the finishing period should therefore be considered in conjunction with what is known about the previous growth path.

Using the same data set as for Perry et al. (1999), the effect of feed on RBY% after adjusting for growth rate during backgrounding and finishing was determined. Pre-weaning growth was not known. Separate analyses were done for temperate and tropically adapted breeds.

The results were very similar to those found when the data was not adjusted for growth rate, and showed that at the same carcase weight and fat depth:

- Temperate animals still had 2% lower RBY for feedlot compared to pasture finished cattle.
- For tropically adapted breeds finished in NSW feedlotting yielded 3% less than pasture finished animals.
- There was no difference in RBY% between feedlot and pasture finished animals from Queensland.

Within a contemporary group, individual animals are under the same management and environmental conditions. Differences in growth rate therefore reflect an animal's own capacity for growth relative to its contemporaries. As animals are usually raised and marketed as groups, a similar analysis looked at the effect of feedlotting versus pasture finishing on the mean RBY% from contemporary groups within the CRC after adjusting for group growth rate, which in this case adjusts for differences between groups. For feedlot finished groups the mean group ADGf was 1.37 kg/day with a range of 0.66 to 1.98. For pasture finished groups the mean group ADGf was lower at 0.61 kg/day with a range of 0.24 to 1.25.

The results showed that:

- Feedlot finished groups had a mean RBY% 2.5% lower than pasture finished groups,
- Mean RBY% decreased by 2.3% as group growth rate increased by 1kg/day.

As there was little overlap of group ADGf at pasture and in the feedlot, with ADGf in feedlot groups almost 1kg/day higher than those finished on pasture, it is not possible to categorically state whether the difference in yield was due wholly to a difference in growth rate or a difference in the energy density of the feed available.

*Compensatory growth*: Although some CRC groups/animals had very low growth rates during backgrounding, which resulted in some compensatory growth (Robinson et al. 2001), the effect of this on RBY% was not significant. However many studies indicate that compensatory growth during finishing may affect carcase composition and consequent yield, depending on when the growth setback occurs, its duration and severity, and whether slaughter occurs before or after full compensation. The differences can be an increase in fatness and decrease in yield, or vice versa, depending on these factors.

## Grain feeding and eating quality

As with yield, any difference in eating quality due to feedlotting versus pasture finishing may be due to difference in growth rate, or age at slaughter. This section looks first at the effect of diet on eating quality, and then at the effect of diet when adjusted for difference in age and growth rate.

### *Nutrition – Feedlot v pasture*

The effect of feedlot versus pasture finishing on the mean tenderness and palatability scores of the striploin from contemporary CRC groups was as follows:

- Mean MSA palatability score was 4.4 units higher in feedlot groups than pasture finished groups, but this difference disappeared when adjusted for difference in mean age at slaughter.
- Mean shear force was 0.34kg lower in feedlot than pasture finished groups, but there was no difference when adjusted for difference in mean slaughter age between groups.
- Mean compression was 0.2kg lower in feedlot groups compared to pasture finished groups. Difference in mean age at slaughter reduced the difference to 0.13kg.

As one of the expected differences between feedlotting and pasture finishing groups would be their group growth rate, and therefore their mean age at slaughter, it is not surprising that adjustment to a similar mean age, within market, accounts for the difference in shear force and palatability score. The difference in compression, despite adjustment for mean age, suggests that there is a small effect of feedlotting which cannot be attributed solely to age.

### *Growth rate*

Studies have revealed no consistent relationship between growth rate of groups of cattle and tenderness, with some reports showing faster growing groups of cattle to have more tender meat than slower growing groups, whilst others show no relationship between growth rate and shear force or tenderness in fast or slow growing groups.

In the previous analysis, adjusting for mean age at slaughter may have been effectively adjusting for the difference in growth rate between grain and grass fed groups, which resulted in the final difference in age at slaughter. After adjusting for difference in growth rate between groups:

- There was no difference in mean MQ4 of feedlot versus pasture finished groups.
- There was no difference in shear force between feedlot and pasture finished groups.
- Feedlot groups had a compression value 0.5kg lower than pasture finished groups.

The difference in mean MQ4 values and mean shear force between feedlot and pasture finished groups when not adjusted for either growth rate or age would therefore seem to be due to growth rate, or difference in slaughter ages due to different growth rates.

The difference in compression, however, existed between grain and grass fed groups regardless of finishing growth rate or age at slaughter, suggesting a direct effect of feedlotting versus pasture finishing on this measurement of tenderness, which largely reflects the connective tissue component of meat texture. Miller (1994) suggested there was a direct effect of diet on connective tissue, whereby feeding high-energy, intensive, diets increases the solubility during cooking of heat-labile connective tissue.

## Marbling and palatability

A common perception in the meat production/processing and food service industries is that higher marbling gives rise to more tender beef.

- The relationship between marbling and tenderness is low and inconsistent, with some studies showing a small positive association and others no perceivable trend.
- Dikeman (1987) concluded that marbling accounted for approximately 10 to 15% of the variance in taste panel tenderness scores.
- Most studies have been done in the USA and these show that increasing marbling decreases the variability in the palatability of beef.
- At the marbling scores found in Australian product (AUS-MEAT score 0-3, intramuscular fat below 7%), intramuscular fat content probably explains only a minor proportion of the variation in tenderness.

Using data on grilled striploins from the MSA database, which includes commercial as well as CRC animals, the association of AUS-MEAT marbling score with the distribution of animals between the MSA palatability grades, as assessed by the consumer taste panels, was determined (Perry *et al*., 1999). The meat was from low *Bos indicus* content carcases which had been hung by the Achilles tendon and aged for 14 days prior to cooking as a grill and served to consumers.

The results showed that:

- A higher marbling score increased the probability of a striploin being assessed as being in a higher grade. That is, MQ4 score was increased (Table 1).
- However, high marbling did not eliminate the possibility of failure, with 13% of marble score 3 product failing the consumer taste panels.

Table 1. The effect of marbling score on the distribution between the MSA grades assigned by the consumer taste panels. Numbers are the percentage within a marbling score that were assigned to each of the MSA grades. (Perry et al. 1999).

| | AUS-MEAT marbling Score | | | |
|---|---|---|---|---|
| MSA Grade | 0 | 1 | 2 | 3 |
| 5-star | 2 | 5 | 8 | 20 |
| 4-star | 23 | 32 | 56 | 53 |
| 3-star | 38 | 42 | 27 | 14 |
| No grade | 37 | 21 | 9 | 13 |
| Total | 100 | 100 | 100 | 100 |

Another theory popular with the food service sector is that marbling provides an insurance against the negative effects of overcooking. Fat conducts heat at a slower rate than lean and this supposedly protects and insulates the muscle fibres against the shrinkage and denaturation that occurs as meat is exposed to high cooking temperatures. Highly marbled beef would therefore be expected to be both more tender and more juicy than lowly marbled product if cooked to a higher degree of donenesss.

- When steaks across a range of marbling scores were cooked to rare and well done endpoints and then assessed for tenderness by a taste panel (Rymill et al. 1997) there was no difference due to marbling. Degree of doneness was considerably more important in producing tender and juicy steaks than was intramuscular fat percentage.

*Marbling, flavour and juiciness*: Marbling fat does impact on juiciness and flavour. The higher fat levels in marbled meat stimulate salivation and give the perception of increased juiciness whilst chewing. Beef with a higher intramuscular fat content will also sustain the feel of juiciness in the mouth, as well as impacting on beef flavour, given that the species specific flavours are contained in fat. However Muir et al. (1998) concluded that when compared at the same fatness or carcase weight the majority of experiments showed little difference in flavour due to grain feeding.

Results from Perry et al. (1999) showed that:

- Within the different MSA grades there appeared to be no relationship between AUS-MEAT marbling score and tenderness (Table 2).
- The correlation coefficients between marbling score and both juiciness and flavour increased from MSA no-grade to the 2, 3, and finally the 5-star category.

Table 2. Correlations coefficients between AUS-MEAT marbling score and consumer sensory score, within MSA grades, for grilled striploin steaks aged for 14 days. Source Perry et al. (1999).

| | Sensory Attribute | | | |
|---|---|---|---|---|
| MSA Grade | Tenderness | Juiciness | Flavour | No. of cattle |
| 5-star | - 0.18 | **0.36** | **0.24** | 167 |
| 4-star | 0.02 | 0.20 | 0.20 | 1322 |
| 3-star | 0.04 | 0.12 | 0.11 | 1646 |
| No grade | 0.08 | 0.09 | 0.09 | 1007 |

The high correlations between sensory dimensions (tenderness, juiciness, flavour) make it difficult to examine simple relationships between the different sensory traits and variables such as marbling, as the relationship between flavour or juiciness and marbling in part reflects changes in tenderness.

Thompson (2001) looked at the relationships between flavour and juiciness traits and marbling in 3,163 striploins from the CRC program, after adjusting for shear force, an objective measure of tenderness. By including shear force in the analysis, the confounding between tenderness and other sensory dimensions was reduced. The variation in sensory scores and shear force was large. Intramuscular fat percentages were skewed towards the lower levels with a mean of 3.3%, but did range up to 15%.

The results showed that:

- Much of the variation in flavour and juiciness was related to shear force. As shear force increased (i.e. samples became tougher) juiciness and flavour scores decreased.
- There was still a strong relationship between intramuscular fat percentage and both sensory juiciness and flavour scores, after adjusting for shear force.
    1. This relationship was curvilinear (Figure 1), with adjusted flavour and juiciness scores increasing as intramuscular fat percentage increased, but at a lesser rate at the higher levels of intramuscular fat.
    2. The improvement in juiciness and flavour scores due to intramuscular fat percentage appears to plateau at the higher levels of intramuscular fat, for beef served as grilled steaks.
- Grain fed beef had slightly better juiciness and flavour scores than grass fed beef. This difference was evident even at the same level of marbling for carcases finished in Queensland, but not those finished in NSW, indicating that in the latter case the difference was due to difference in intramuscular fat levels.

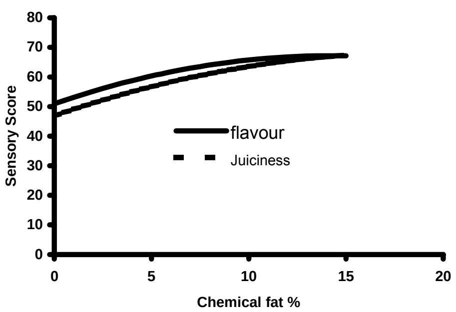


Figure 1 The relationship between flavour and juiciness scores as a function of chemical (intramuscular) fat percentage in grilled striploins, adjusted to a shear force of 5.0kg. (Thompson, 2001).

## Summary

- Feedlot carcases will yield about 2% less than pasture finished carcases, at the same carcase weight and fat depth. This may be due to a combination of diet *per se* and the higher growth rate of feedlot cattle.
- Feedlot cattle will usually have slightly more tender, palatable meat. This is due to one or more of the following:
    1. Higher growth rate
    2. Younger age at slaughter
    3. Higher marbling (intramuscular fat)
- Compression (which is largely a measure of connective tissue toughness) is lower in feedlot beef regardless of age at slaughter.
- Higher marbled meat is more likely to be rated as more palatable by consumers.
- Marbling is associated more with juiciness and flavour, than with tenderness itself.
- Improvement in juiciness and tenderness may plateau at higher levels of intramuscular fat.
- The advantage in flavour scores in feedlot compared with pasture finished beef is due to the increased intramuscular fat and their younger age.
    1. If these variables are similar there is little difference in flavour between feedlot and pasture finished beef.

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