Summary of Growth and Nutritional Influences on Marbling

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- Marbling is a valuable trait in some markets. While marbling is particularly important for the Japanese market, it also is included in our domestic MSA grading system.
- Nutrition can increase the rate of intramuscular fat development primarily by supplying more net energy for fattening. However currently we do not have ways of specifically stimulating marbling at the expense of other fat sites
- Nutrition before feedlot has a significant effect – poor nutrition gives less marbling and good nutrition gives more marbling.
- Genetics is very important. To obtain maximum response to feeding for marbling the animals must have the genetic makeup that will lead to marbling
- The genetic propensity to marble probably relates to the number and position of fat cells. If an animal has the propensity to develop marbling precursor cells in muscle, it has the propensity to fully express marbling when it is well nourished.
- Genetic rankings for marbling generally hold over a range of nutritional regimes. i.e. animals with a genetic superiority to marble will show this on grass or different periods of grain feeding. In technical terms: the genetic correlation for marbling between different nutritional environments in CRC research was high – close to 1.

What do we know about marbling?

Marbling is fat within the meat (muscle) of cattle. It is important to eating quality because it contributes to the flavour and juiciness of meat. Marbling is included in Australia's beef grading scheme because it contributes to overall eating pleasure.

Marbling becomes visible in the meat of cattle once they are fattened, though it may develop earlier in some cattle but can't be seen without a microscope.

Marbling develops readily in animals with the right genetics, when given the right nutrition. Cattle with inappropriate genetics will not develop marbling no matter how long, or how well you feed them – they just haven't got the potential to marble. The development of marbling can be monitored by ultrasound scanning in the living animal. Marbling fat often replaces muscle connective tissue and contributes to more tender meat. This paper provides some facts regarding nutritional effects upon marbling.

Development

Fat cell number is the important determinant of marbling, as well as genes and nutrition. Marbling fat cells continue to develop later in life; i.e. there are more small fat cells in muscle than other fat depots. Intramuscular fat (IMF) as a % of total carcase fat stays constant, i.e. IMF over the whole carcase develops at the same rate as other depots. Therefore to get an increase in marble score or IMF%, we need muscle growth to slow in the face of sustained fat growth. For British type cattle with some genetic propensity to marble, the IMF% does not start increasing until about 200kg carcase weight – after this time there is a linear increase with time, up to about 500kg carcase weight and after this any further increase is relatively small.

The heritability of marbling is about 30 to 50%. In genetic terms, this is quite high and means we can select for marbling with reasonable success.

Nutritional Affects

Net energy intake is a key to fat deposition. For this reason, grain is better than grass. Remember that net energy is the energy available for growth after everything else is covered - exercise, thermoregulation, maintenance for pumping ions and protein turnover etc.

Optimising net energy intake in a feedlot situation is all about high grain inclusion and optimal grain processing so as the digestive system of cattle can extract as much energy from the diet via both optimising digestion in the rumen and small intestine. This usually means pretty heavy processing of grain, BUT at the same time, not compromising the animal's health with acidosis. Fat can be used in the diet, because it increases the net energy - but alternate cost-effective sources are not readily available. Indeed simple rations based on cereal grain such as barley and roughage alone (i.e. no added protein grain source) perform well – older and heavier cattle have a relatively low requirement for protein.

Manipulating rations to increase marbling

It is difficult to specifically promote the development of intramuscular fat alone since fat deposition

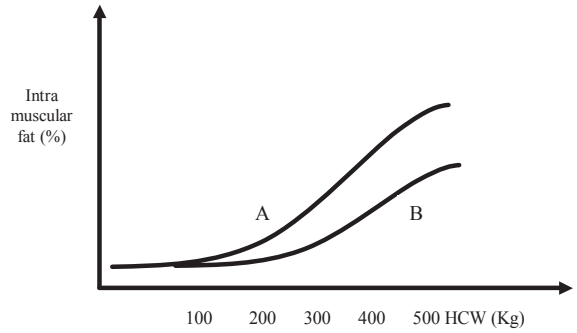

Figure 1. Development of intramuscular fat in cattle of different propensity to marble (A>B).

is typically linked across the body. The Beef CRC (& MLA) has tried canola oil plus calcium, Rumentek™, low protein, high protein, different grains (maize, barley, oats) and the central outcome has been the availability of net energy for fattening.

Vitamin A deficiency does produce a small increase in marble score (shown in cattle, pigs and lambs). While vitamin A manipulation offers some potential for increasing marbling fat, independent of other fat depots, doing so at levels that compromise the health and welfare of the animal, will not be acceptable to the community as a whole. The greatest value of vitamin A research has been in illuminating a potential mechanism – that is the vitamin A metabolic pathway as a whole – that could be manipulated to increase marbling.

Growth effects

Higher growth during backgrounding gives higher marbling levels when cattle are finished in a feedlot. An early growth check decreases marbling, increases fat trim and increases the level of subcutaneous fatness. Slower pre-feedlot growth (backgrounding) resulted in less marbling. The role of nutrition for Japanese export cattle is likely to be higher in shorter term, long-fed programs (<250 days) as longer term long-fed programs (350+ days) allow fat deposition to catch and reach the theoretical maximum (Figure 1).

Northern grown and finished cattle in CRC trials always had less IMF% than their southern finished brothers and sisters (on a sire basis). Interestingly, these northern cattle had more subcutaneous fat and lower yield. We don't yet understand why the northern cattle had lower IMF% combined with higher subcutaneous fat compared to their southern finished brothers and sisters, as shown below. Note that the northern cattle were 5 months older at slaughter.

Assessing Marbling

Visual marbling score assessed by trained graders and chemical marbling fat are positively correlated (about 70%). Ultrasound scanning is used to measure IMF% of live cattle. CRC research has greatly assisted the development of this scanning technology in Australia and its use in BREEDPLAN and feedlots.

For the same fat content, higher visual marbling scores are obtained when:

- Temperatures are less than 5°C vs 10°C – important since most carcases are brought up to about 10˚C early in the morning before boning – this usually coincides with the grading or visual assessment step – one solution is to hammer the chillers for about 30 minutes to chill the surface of the loin.
- Time of chilling is longer and carcases have *hard* fat
- Carcases are assessed at 5/6 rib (fat content and marbling is less at the 10/11/12th ribs)
- Marbling is naturally variable within a site That is, distribution can be quite uneven through the muscle.

What can you do to influence the development of marbling?

1. Choose genetically superior animals
   - Use bulls with high EBV's for marbling
   - Use gene markers (GeneStar Marbling test)
2. Choose the right diets
   - Feedlot
   - Grain supplementation to grazing
3. Minimise stress during feeding and pre-slaughter
4. Processors need to ensure careful chiller management and assessment needs to be at a controlled, low temperature.

Table 1. Northern vs Southern finished CRC research cattle

	Dressed Wt (kg)	IMF %	Rib Fat (mm)	Yield (%)
Northern finished	239	3.7	18	68.1
Southern finished	232	5.4	12	73.0