

## **Much Ado about Marbling**

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### **What is marbling?**

Marbling refers to the little specks of fat dispersed in lean tissue that translates into big bucks for the beef producer. It is considered the best indicator of eating satisfaction when consumers enjoy beef. Higher levels of marbling result in better flavor and juiciness. Although marbling does not guarantee tenderness, well marbled beef can be cooked to a higher degree of doneness and still maintain juiciness. This seems especially important for roasts.

### **Why is it important?**

Marbling is almost the sole indicator of USDA quality grade, which ranges from Standard to Prime. Although some people contend that well marbled beef is too fat to be healthy, there is only 4.5 percent fat in a trimmed Low Choice rib steak. In recent years there has been a proliferation of branded products such as Certified Angus Beef and Sterling Silver using carcasses that grade Average Choice and higher. Often the grades Average Choice and High Choice are referred to as Premium Choice. Only 2 percent of all carcasses grade Prime while about 50% grade Choice. Beef with virtually no marbling that would grade USDA Standard is usually left ungraded but some brands such as “Laura’s Lean” actually specify beef with little or no marbling.

### **Breeds and marbling**

Marbling is very highly related to breed. Jersey is especially high in marbling but the Japanese Wagyu probably is the highest marbling breed in the world. In Japan there are three marbling grades above the USDA High Prime and fat content in the rib eye muscle sometimes is 45 percent and higher (10 times the amount in USDA Low Choice). There is a mail order steakhouse that sells Wagyu steaks for over \$100 per pound. Angus cattle are noted for exceptional marbling and that breed has devoted considerable attention to exploiting EPD’s and ultrasound technology to improve carcass characteristics. Most of the breeds that originated on the European continent, where emphasis was on milk and work, are low in marbling. Also, Bos indicus (Brahman) usually have little marbling. The heritability of marbling is about 0.40; so where genetic selection has focused on this trait (as among Angus), it has been substantially improved.

Marbling is deposited near the blood vessels that nourish the longissimus (rib) muscle. That suggests that it is a quick mobilized source of energy to supply the animal during stress. Perhaps that is the reason that those breeds that evolved in cold climates or produce abundant levels of milk and butterfat at parturition tend to have more marbling. The deposition of marbling in the longissimus is not random but is fractal (treelike) because the intercostals arteries that feed this muscle enter between the ribs and then branch through the muscle. Consequently moving the slice that splits the carcass into quarters as little as ½ inch may affect the visual marbling as much as a full degree.

## **Marbling development**

There is little relationship between marbling and backfat thickness among cattle of the same breed composition that have been fed the same length of time. That contradicts the classical paradigm that there is a sequence of fat deposition where marbling is deposited only after the other fat depots have become filled. It is almost as if there is an either/or effect where excess energy is either deposited as subcutaneous fat or as intramuscular fat and the site is genetically controlled.

The progression of marbling among feedlot cattle is slow. It appears to take about 114 days to progress from the bottom of the Select grade (slight marbling) to the bottom of Choice (small marbling). Then it requires about 70 days to move from Low Choice to Average Choice (modest marbling) and another 90 days to attain Low Prime (slightly abundant marbling). But this rate of increase may be breed dependent and some breeds may plateau at some point. Although the progression of marbling is slow in the feedlot animal, backfat thickness increases at an exponential rate. So the practice of feeding a pen of cattle longer in order to attain a few more Choice carcasses probably will result in a much greater increase in the fatter yield grades (YG #3 and YG #4).

It is difficult to perform accurate research on marbling. The trait is not distributed according to the Gaussian (bell shaped) curve so conventional statistics are not appropriate to analyze results. (This probably has resulted in some scientists erroneously concluding that marbling did not differ among treatments). Serial slaughter is confounded with time and conditions for collection marbling scores may vary at different slaughter dates. Marbling is a subjective measure of the visual assessment of the appearance of rib eye face. Variations among graders of 0.6 to 0.8 average marbling score units have been documented. Also, it is very important that the carcass be thoroughly chilled before marbling is recorded. Marbling scores may vary according to whether the carcass was kept in an area where chilling was effective or along a wall where air circulation was poor.

Because marbling scores tend to cluster in the High Select and Low Choice categories, each 0.1 increase in marbling score may be associated with as much as 7.6 percent increase in percent Choice in a group of cattle.

## **Factors other than breed**

Marbling is affected by implants and hormones. Bulls have about a full degree less marbling than steer contemporaries. Heifers have about 0.6 more marbling. The aggressive implants reduce marbling. In the mid 1970's we observed that reimplanting reduced carcass grade. But the reduction seemed affected by the number of implants during the lifetime of an animal and severe reduction did not occur until cattle had been implanted more than three times. In most experiments that evaluate the effect of implant treatments on carcass grade, the previous implanting regime is unknown. Although management may improve marbling, it is unlikely that ration composition, per se, has an effect. We have won most of the leading carcass contests with cattle that were fed only milo.

There is a need for more information about the relationship between marbling and reproductive performance. Higher marbling should be associated with early puberty and better milk production in females. In a small experiment, pregnant heifers graded better than contemporaries that failed to become pregnant (but perhaps heifers that conceived did so because they had better marbling). There has been a concern that selection for higher marbling in bulls might also be associated with reduced testosterone levels.

## **Ultrasound to estimate marbling**

Ultrasound has become a powerful tool to estimate marbling in the live animal. Marbling does not register as such on the ultrasound image, but an artifact called ultrasonic speckle can be evaluated to assess the amount of marbling. This feature results from backscattering of the sound wave when it encounters marbling deposits and is comparable to the behavior of light waves on a foggy day. A combination of image analysis and pattern assessment procedures linked with neural network technology (computer vision) enable analysis of marbling with accuracy, although a skilled sonographer can estimate marbling from visual inspection of the image, interfacing the ultrasound instrument to a computer enables an objective analysis in a fraction of a second. The average error between ultrasound estimated marbling in live animal and subsequent carcass marbling is about 0.5 marbling score units. This is suitable for the technology to be a valuable tool to assist producers but may not be precise enough for much scientific research. Estimates of future marbling from evaluations made early in the feeding period have only slightly lower accuracy than those made just immediately before slaughter.

## **Ultrasound marbling applications**

There are many applications of the ability to estimate marbling in the live animal. One is to assess marbling in seed stock animals when emphasis is on selecting for this trait. That should not be limited to purebred herds because one of the most valuable uses of the technology is to assist in selecting replacement heifers in commercial herds. Ultrasound has been exploited to collect data for carcass EPD's by many breed associations. This has enabled much larger samples than when that information had to be collected in the packing plant.

Our application is primarily used at reimplanting time where present carcass attributes are measured and those values used to project days to continue to feed each animal to maximize profit. The projection model may increase days for feeding high quality animals in order to obtain more pounds of high-value product. Conversely, animals that have little likelihood of grading Choice may be more profitable if sold early and while yield grade premiums can be obtained. An estimate of quality and yield grade distributions may also enable more effective marketing by fitting cattle to an appropriate packer grid.

This technology also enables clustering cattle into outcome groups for more effective marketing. The present batch marketing system that involves harvesting an entire pen of cattle on one day is one of the most inefficient practices in agriculture. Ultrasound technology offers the ability to incorporate the tenets of precision agriculture into beef production.

An especially intriguing application results from the ability to assess calves and feeder cattle for future marbling potential. At that stage of development it is unlikely that ultrasound registers marbling that can be seen in the carcass if the animal were harvested at that time, but a signal that is generated by the unfilled adipocytes is highly correlated with carcass grade when cattle are marketed as much as 10 months later. This might enable an early assignment to a management and marketing program for which each animal is best suited. This is compliant with the contention that the feeding and marketing strategy should be chosen to fit the animal and not the reverse, which is so widely practiced currently.

This application was used and subjected to a critical test in the Best of the Breed contest in 2002. In this contest, candidates were selected before being placed on full feed and at least 100 days before harvest. We screened about 280 head in January when the 80 candidates that we selected for our entry averaged 690 pounds and 10 months old. The first half were harvested June 4 and the second half on July 10 (5 and 6 months after selection). All these cattle graded Choice or better; 91 percent were at least Average Choice and 32 percent were Prime. There were no yield grade #4 carcasses and 30 percent were YG#1 and YG#2. Especially remarkable was the fact that the top eight of 140 entries used the same ultrasound technology for selecting entries.