Stacking Management Traits for Marbling

A literature review by a University of Georgia researcher enumerates the little things that can add up to focused marbling management.

Story by
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With 37% of observed differences in marbling attributed to heredity, marbling is considered among the "highly heritable" traits; but that means 63% of final marbling depends on environment, nutrition and management. You can stack the genetic odds in your favor by selecting generations of Angus cattle that are above breed average for marbling, yet fail to capitalize on your investment for lack of attention to everything else.

That "everything else" can seem like an overwhelming challenge. Everything that you, the weather, other people or other cattle do to your cattle will affect their performance, quality grade and grid value. Like everyone else in the beef industry, you need to get a handle on this vast area governing profitability.

You may have heard that implanting with growth promotants lowers quality grade, that time on feed increases quality grade and that specialty feeds, such as high-oil corn, can increase marbling scores. That's all true in general, but profitable cattle feeding has little room for generalities. You need specific strategies to stack individual management practices.

A scientific literature review prepared for the Great Plains Beef Conference and redirected with funding from Certified Angus Beef LLC (CAB) nails down the specifics and points the way toward focused management. There's still no silver bullet in the arsenal of nutrition and management practices that affect marbling, but there's enough ammunition — if used strategically — to win profitability battles.

Susan Duckett of the University of Georgia in Athens has analyzed the existing research on the effect of nutrition and management practices on marbling deposition and composition and has compiled the results into a White Paper. The bibliography lists 77 research articles spanning 40 years and studies of specific marbling components' effect on human health. The White Paper and its bibliography are on the CAB Web site at *www.certifiedangusbeef.com/cabprogram/html/producers.htm.*

Marbling and its parts

Duckett started with the observation that marbling is a major determinant of carcass value and predictor of palatability. Marbling is composed of 20 individual fatty acids, six of which make up 92% of the marbling and are split about evenly between saturated fatty acids (SFA) and mono- and polyunsaturated fatty acids (MUFA and PUFA).

Unsaturated fats may be considered more desirable due to their effect of lowering serum cholesterol levels in consumers. One minor PUFA, conjugated linoleic acid (CLA), has gained media attention due to its cancer-fighting properties. Cattle diet and management can shift the relative balance of these fatty acids in beef products.

The ability to affect marbling amount is important in today's value-based markets. The ability to affect composition also is important long term, as beef achieves an increasingly stable position in the human diet, Duckett says. The results from several studies show there is no significant difference in human serum cholesterol among diets containing lean beef, plant protein or white meat.

"Lean beef simply means trimmed of external fat," Duckett explains. "There is very little difference in the amount of fat between Select and *Certified Angus Beef* ™ (CAB®) product, but the higher marbling cuts have more of the CLA."

While the anticarcinogen CLA may be important to consumers, Duckett says it does not comprise a large enough share of marbling to provide a physiological effect in cattle. Increasing the relative percentage of this small component may help consumers at no cost to producers, and Duckett continues to study that prospect.

Nutritional aspects

The potential to alter marbling deposition and composition depends on a number of individual small to moderate effects from nutrition and management. One key is helping more dietary unsaturated fat escape rumen changes that tend to convert as much as 70% of it to saturated.

"The fat in most cattle feedlot diets is largely (79% average) unsaturated," Duckett says. "The rumen wants to put a hydrogen bond on it and convert it to a saturated fat, and that's what will pass on out of the rumen for absorption and deposition. If you fed a monogastric animal unsaturated fat, it would deposit unsaturated fat. The rumen tries to change that."

Research comparing forage to grain finishing found that grain diets increase marbling scores and quality grade dramatically. S.E. Williams and others reported in 1983 that a forage-fed group graded 45% Standard, 50% Select and 5% Choice while their counterparts on grain had no Standards, 35% Select and 65% Choice carcasses. Moreover, the forage-fed beef's mix of fatty acids contributed to shorter shelf life and off flavors after cooking.

Time on feed

Regardless of the age or breed of cattle, serial slaughter times continue to demonstrate that, unlike external fat, marbling deposition does not proceed in a linear manner across time on feed (see Fig. 1). For example, 84 days on feed may be the worst time to pull the trigger on a set of feedlot cattle, while another four weeks makes all the difference.

"Most people think marbling just increases — the longer you feed, the more marbling you get — and that's not necessarily the case," Duckett says. "You need a certain amount of time on feed to get them going, and after a certain amount of time, you probably have diminishing returns from keeping them on feed."

Time on feed also governs yield grade. "Since external fat deposition is

linear, the longer on feed, the higher the yield grade. One way to optimize both Yield Grade 2 and Choice cattle is to find that time when they are changing marbling," Duckett says. Research that charted intramuscular lipid percentages in Angus-cross heifers on feed (see Fig. 2) used ultrasound "to help identify when they changed and had reached the Choice grade."

The percentage of heifers grading Choice or better moved from 22% at Day 84 to 78% at Day 100 and remained at about that level through Day 120. The percentage accepted as CAB continued to improve from 3% at Day 101 to 22% at Day 120. While these were uniform cattle from a single ranch, more research is needed to assess optimal time on feed for increasing the percentage of CAB-accepted carcasses, Duckett says.

Fig. 1: Change in the percent total lipid (marbling) within the longissimus muscle as triglyceride (storage component) or phospholipid (structural component)

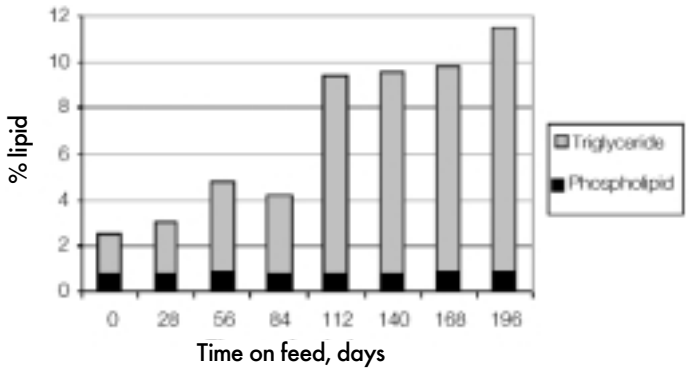
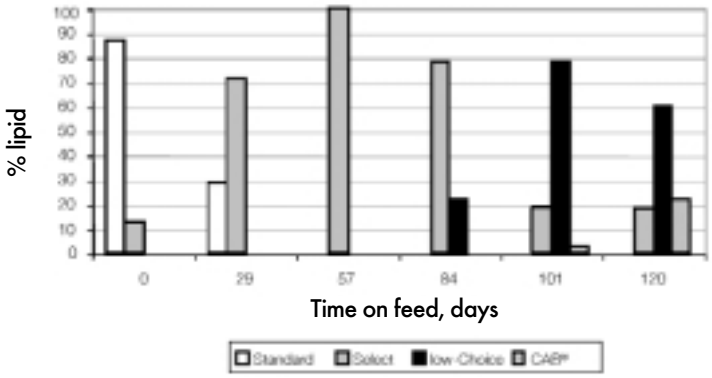
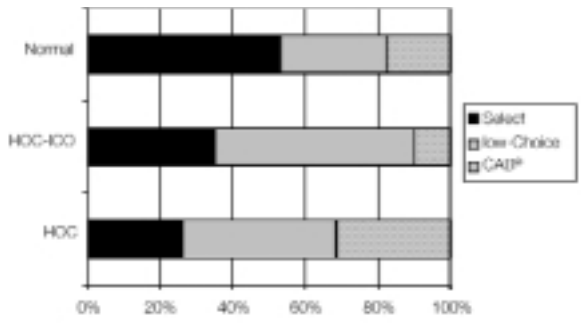


Fig. 2: Changes in the percent of carcasses grading Standard, Select, Choice or CAB® as predicted from real-time ultrasound intramuscular lipid (IML) percentages measured across time on feed in Angus-cross heifers[a]



[a]Standard is less than 3.4% IML; Select is 3.4% to 4.99% IML; low-Choice is 5% to 6.49% IML; and CAB is at least 6.5% IML.

Fig. 3: Effect of feeding high-oil corn for 83 days, at a ration percentage (HOC) or at a caloric level (HOC-ISO) similar to normal corn, on percentage of carcasses from Angus-cross steers grading Select, Choice or CAB



Fat, oil and oilseeds

Yellow fat, tallow or grease has been fed with mixed results in an attempt to increase marbling scores. At 4%, tallow in a corn ration decreased marbling scores, but at slightly lower levels, and in barley and sorghum diets, tallow increased marbling scores while slightly increasing marbling saturation.

Research in the area of feeding unsaturated oils that are protected from rumen biohydrogenation by calcium and protein shielding is still inconclusive. Some researchers contended oilseeds were naturally protected by the seed coat and tried feeding cottonseed as a rumen-bypass fat. However, a large percentage of these seeds remained "protected" and wound up in feces. Chemical treatment of canola with sodium hydroxide and hydrogen peroxide is a promising area of research.

Feeding whole soybeans, from 2% to 24% of a finishing diet, had a neutral to slightly positive effect on marbling score, while feeding 14% extruded soybeans showed slightly more-positive effects on marbling.

Specialty grains

In the 1990s scientists developed corn that had twice the oil content of most varieties, and a few research trials have looked at the potential for this high-oil corn to affect marbling.

With the higher unsaturated fat levels, "we don't necessarily reduce the amount of biohydrogenated corn, but the rumen can't get everything, and a certain percentage escapes — like 30%," Duckett explains. "If you put more in, like with high-oil corn, more unsaturated fatty acid comes out to the small intestine that isn't hydrogenated."

A balance must be maintained, no more than 2%-4% additional oil, or you reduce consumption and feed efficiency, she adds.

In short, the specialty grains had a big effect on grade, increasing Choice-grade cattle from 42% to 72% in one study and from 43% to 57% in another. The percentage of carcasses qualifying for CAB acceptance was nearly twice as high (33.3% vs. 17.6%) in one study when high-oil corn was fed at the same ration level as normal corn (see Fig. 3). However, feeding high-oil corn at a caloric level similar to normal corn yielded a much lower CAB acceptance level (11.1%) despite a marked improvement in percentage grading Choice.

"We did see differences in the marbling fat composition as well," Duckett says. "That showed us it had to be a result of dietary fat. If the composition of fatty acids had been different, we might have concluded the higher levels of marbling were due to an increase in fat synthesis."

The research suggests high-oil corn should be fed in combination with higher levels of silage or hay.

"The bacteria that change the fat and produce CLA typically like higher-fiber diets," Duckett explains. While there is no immediate market advantage to enhancing CLA content of beef, she notes it makes sense to keep research ahead of the market. "The National Cattlemen's Beef Association is looking at what we can do first, then we might move along to whether we can label some beef as higher in CLA," she says.

Management effects

The scientific data show age and backgrounding systems have little effect on marbling. "We typically hear weaned cattle going into the feedlot won't grade as well, but research shows that is not the case," Duckett says. The most recent trial cited featured Angus cattle of similar genetics from two Oklahoma ranches.

Use of ionophores, such as Rumensin®, Bovatec® and Catalyst®, limit biohydrogenation to some degree, but they don't make a major difference — in themselves, Duckett says. "Used with high-oil corn, ionophores may be more positive to marbling composition."

In contrast to feeding high-oil corn, management practices that stimulate muscle growth, such as the use of anabolic growth implants, appear to reduce marbling deposition by dilution.

Implants

On average, anabolic implants reduce marbling scores by 24% of a degree and percent grading Choice by 14.5%. The primary benefit of using these growth promotants is an increase in ribeye area, but that is negatively correlated to marbling — as ribeye size goes up, marbling score goes down.

A recent study of Angus-cross cattle fed 127 days and implanted either not at all, once at the start or reimplanted at 60 days showed the highest level of CAB acceptance, at 20%, for the nonimplanted group (see Fig. 4). The second-best strategy for quality grade only was either a single, combination estrogenic/androgenic implant at Day Zero or an estrogenic implant at Day Zero followed by the combination type at 60 days. The worst effect on grade appeared to result from two implants of the same formula or type.

"Every study tends to be a little different, so it's hard to make generalizations," Duckett cautions. Moreover, new data from Duckett's work suggest cattle with sufficient genetic propensity to grade cannot be held back by implant.

"We just fed a group of Angus cattle with known high marbling potential and did not find any significant difference in marbling scores of these cattle, regardless of implant," she says. "We did see the increases in ribeye size, however. Ribeye area increased, but we did not see a decrease in marbling score or CAB acceptance."

This was a relatively small study, Duckett notes, looking at enzyme activities of the marbling fat to see if management directly affects marbling deposition or changes lean deposition.

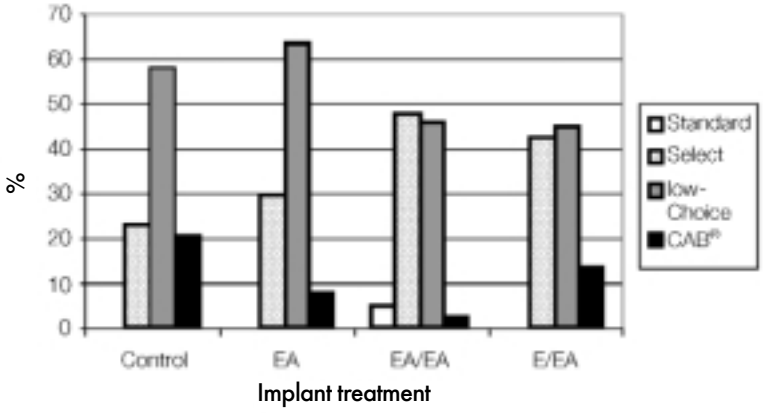
Conclusion

Nutrition and management systems can alter marbling deposition and composition. Marbling deposition appears to proceed in a nonlinear manner across time on feed, with a plateau after about 112 days on a finishing diet. Increased marbling scores have been observed in cattle fed increased levels of dietary unsaturated fatty acids in the form of oilseeds, protected oil supplements or added vegetable oil.

The increases in marbling score are typically accompanied by increased unsaturated fatty acid composition of marbling fat. Increasing the dietary supply of unsaturated fatty acids results in higher levels of unsaturated fatty acids' escaping ruminal biohydrogenation for increased absorption and deposition in marbling fat. In contrast, management practices that stimulate muscle growth, such as use of anabolic implants, appear to reduce marbling deposition through dilution effects.

Based on these research findings, it appears that certain events must occur in order to alter marbling fat deposition and composition. These events include increased marbling deposition in the time period when diet is altered; increased flow of unsaturated fatty acids to the small intestine as a result of reduced ruminal biohydrogenation, higher dietary intake or both; and increased absorption of the unsaturated fatty acids in the intestine for deposition. Additional research is needed to explore regulation and potential nutritional manipulation of marbling deposition and composition.

Fig. 4: Effect of implanting on the percentage of carcasses grading Standard, Select, low-Choice or CAB[a]



[a] Implant treatment: Control = not implanted; EA = 28 milligrams (mg) of estradiol benzoate plus 200 mg of trenbolone acetate on Day Zero; EA/EA = 28 mg of estradiol benzoate plus 200 mg of trenbolone acetate on Day Zero and Day 61; E/EA = 20 mg of estradiol benzoate plus 200 mg progesterone on Day Zero and 28 mg of estradiol benzoate plus 200 mg of trenbolone acetate on Day 61; time on feed = 127 days.