Amino Acid Balance – the next step in cattle feeding technology for maximum genetic expression

By Gerald Walker, Ph.D., Product Manager, ADM Alliance Nutrition, Inc.

Beef cattle genetic improvement has made tremendous strides in the past 40 years, some breeds more than others. While methods of cattle feeding have made dramatic improvements over the same time period, feeding technology has not kept pace with the genetics as evidenced by isolated bull performance in which bulls have gained up to eight pounds per day without fat deposition. Cattle feed formulation has historically moved from balancing rations based on total protein to acquiring enough information for balancing the diet while including a certain amount of bypass protein. The University of Nebraska was instrumental in pioneering the concept of including bypass protein in calf rations. The knowledge that growing cattle require a certain level of protein in the diet was an important step in improving feed efficiency, but when cattle feeders began formulating rations based on rumen degradable protein (RDP) and rumen undegradable protein (RUP), the improvements in feed efficiency and growth were even more significant.

With this information, growing and finishing cattle have been able to gain closer to their genetic potential for muscle development and at more efficient rates. With the increase in commodity prices in recent years, the need for more efficient feeding technology has become more important. To achieve more feeding efficiency, the next step in cattle feeding is to follow that of the monogastric livestock industry where balancing rations based on individual amino acids balance is logical. The monogastric industry was able to move to this next level of feed formulation about 30 years ago when it began formulating rations based on the first-limiting amino acid and then included other limiting amino acids. When the ration is balanced based on individual amino acid levels, feed efficiency improves by up to nine percent. Because rumen microbes have the ability to change dietary amino acid composition, formulating for limiting amino acids in the ruminant is more complicated than with monogastric animals.

Balancing for Amino Acids and the Effect on Genetic Potential

It is well known that the building blocks of protein (muscle protein) are amino acids. There are about 20 amino acids that make up these protein molecules which are assembled together in an exact sequence determined by DNA. The process of converting DNA sequence to muscle protein does not allow for substitution of one amino acid for another when there is a deficiency of a certain amino acid. If there is a deficiency of one or more amino acids in relation to their requirement for maximum genetic lean tissue synthesis, protein synthesis is slowed or stopped depending on the degree of deficiency. This manifests itself as poor feed efficiency in that a single deficient amino acid limits the use of other amino acids, resulting in the excretion of a greater amount of these nutrients.

Ten of these amino acids have been termed as essential (indispensable), which means they must be provided in the ration because the metabolic system cannot synthesize them in adequate amounts to meet requirements. So, what does it mean to balance a ration based on individual amino acid requirements? Amino acid balance means to provide the amount of each essential amino acid in the ration to complement that which is supplied by the microbial protein thus ensuring that the amount reaching the small intestine for absorption is very close to the animal’s requirement for maximum tissue protein synthesis, without excesses.

In current beef rations, a deficit often exists between the empirical amount of essential amino acids the rumen microbial population is capable of producing and what the animal actually needs in order to reach genetic potential for gain (see Figure 1). If the overall amino acid profile reaching the small
intestine matches the profile needed for lean tissue gain, gain will occur in an efficient manner. Microbial protein presents a nearly perfect amino acid profile to the small intestine. So, when the bypass protein amino acid composition is correct the animal will realize improved gain and efficiency (provided energy level is correct based on growth requirements). However, if the post-ruminal flow (and/or profile) of amino acids does not match biological needs for lean tissue gain, performance will not respond to the added amino acids from bypass protein; performance might even be further limited.

In evaluating current diets, a producer should realize that the amino acid profile of most grain and grain co-product rations do not match the amino acid profile of lean tissue very well. This disparity in amino acid profile translates to the need for rumen bypass amino acids reaching the intestine balanced to the required profile. Based on ADM research, several individual amino acids are deficient in typical growing diets to the point that growth will not reach genetic potential and efficiency can be lost (see Figure 1). These deficient amino acids represent the limiting amino acid(s) for growth.

**Figure 1. Deficiency and excess of required amino acids for lean tissue synthesis based on amino acids supplied by microbial protein.**

Currently, rations are formulated based on the first-limiting amino acid, meaning the amino acid that occurs in the ration in the least amount relative to its requirement. Figure 2 illustrates the essential amino acid profile plotted in graphical form based on typical rations currently fed to growing and developing beef cattle. In this scenario, extra protein has been added to ensure all amino acid requirements are met. This method results in excess protein just to meet the deficient amino acids and often excess nitrogen excretion.
Figure 2. Traditional method of balancing growing diets result in an excess of many essential amino acids.

![Traditional Amino Acid (AA) Balanced Diet](image)

*NRC 2000 Beef Requirements.

This excess in amino acid concentrations in the ration causes inefficiency because the body must process the excess amino acids. Metabolically, amino acids are deaminated, and the amino group is usually excreted in the urine with an energy expenditure to the animal, while the carbon structure is reassembled with most of it laid down as carcass fat. To avoid excess fat deposition in grower/stocker situations, historically the growing calf has been held back or limited in growth (2.5-2.75 lb/day) compared with their genetic potential. This method of diet formulation has historically been a way to promote good finishing performance.

About 10 years ago when ADM Alliance Nutrition** began working on the idea of formulating growing diets based on essential amino acid needs there was very little information available to balance a diet based on amino acid requirements beyond the first-limiting amino acid. Essential amino acid requirements first needed to be researched and then the formulation tested. When the genetic potential was realized, gaps or holes in the amino acid profile began to be evident. These gaps limited the efficiency of growth based on most genetics of today's cattle. Figure 1 illustrates the holes or gaps in the amino acid profile that occur in normal rations. However, when provided the correct balance of amino acids in the diet, growing calves are able to achieve their genetic potential without getting fat, gaining between three and four pounds daily, (see Figure 3 and Table 1). In Figure 3, note that the level of amino acids in the ration above the requirement is lower compared with amounts of amino acids shown in Figure 2. Balancing for amino acids improves efficiency while simply adding more total protein leads to inefficiency.

The ADM Alliance Nutrition position was to try to develop feeding technology that would allow growing cattle to maximize lean growth without depositing excess fat while improving feed efficiency. Through internal research and development, ADM Alliance Nutrition developed AminoGain**

Co-Product Balancer to address challenges presented by current diets. This product provides improved cost of gain through better average daily gain and feed efficiency. During development of AminoGain Co-Product Balancer, limiting amino acids were identified and a blend of consistent bypass amino acid sources were combined to provide the needed limiting amino acids, while minimizing addition of amino acids already present in sufficient quantities (see Figure 3). AminoGain Co-Product Balancer is formulated to optimize ruminal fermentation so that the animal will produce maximal microbial protein through optimal feedstUFF digestion. By balancing amino acids, growing beef calves
gained faster (+10%) and were more efficient (+9%) compared with a conventional feed program. These improvements in feed conversion have become imperative as feed prices have continued to increase.

Figure 3. Balancing amino acids with AminoGain technology resulted in more amino acid levels at the requirement, reducing amino acid excess which allows for better efficiency.

![Amino Acid (AA) Balanced Diet](image)

* NRC 2000 Beef Requirements

Feeding breeding bulls and heifers diets that are amino acid balanced enables these animals to lay down more muscle tissue and minimize fat deposition, which during the breeding season promotes better performance and retention of body condition. The result is increased herd longevity. Fat bulls tend to lose body condition and performance diminishes as the season progresses. Bulls with more muscle mass retain body condition and performance over the course of the breeding season. Table 2 shows bull performance when fed an amino acid balanced ration.

Customers using bulls developed on an amino acid balanced diet have recognized the benefits and are repeat buyers. Dairy heifers that have been developed on diets that are balanced for amino acids have entered the breeding herd on average one month sooner with a higher degree of muscling. Customers have noticed bulls developed on an amino acid balanced diet exhibit more muscle development.

To date, there is only one product in the beef industry that that can effectively balance dietary amino acids, the amino acids beyond the first and second-limiting amino acid. That product is AminoGain from ADM Alliance Nutrition.

*ADM Alliance Nutrition and AminoGain are registered trademarks of ADM.*