Effects of grain feeding on carcass quality and value

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Take Home Message

Cattle can be effectively, and efficiently, fed grain-based diets to optimize growth performance and meat quality. Meat quality is determined by grading systems in the U.S.A. that relate to sensory, or eating, experiences and age of the cattle. Feeding cattle grain-based diets will result in a young animal at slaughter with a well marbled carcass. These carcass traits are desired by consumers because they generally produce meat that is tender and full of flavor.

Introduction

Feeding beef cattle corn grain is a relatively “new” topic in research, as scientific topics go. The first research on the efficacy of corn grain for beef cattle was noted in 1898 (Ball, 1898). Even still, as late as the 1950s, cattle harvested directly from grass represented virtually all of the beef consumed in U.S. (Corah, 2008). Research on the effects of using corn grain as an efficient means to fatten beef cattle began to appear in the 1950s (Perry et al., 1956) and has grown ever since. Corn grain has been the predominant energy feed for all livestock species in the United States of America for over 50 years. One of the major drivers behind the use of corn grain in the U.S. was the price. Corn price in the U.S. remained stable for nearly 30 years and was a relatively cheap energy source (NASS, 2015). Today, the majority, ~80%, of cattle slaughtered in the U.S. are finished (fed) on corn-based diets (Matthews and Johnson, 2013).

Because feed costs represent the majority of the input costs, feed intake and the amount of feed cattle consume is the largest driver of economic success in the feedlot. Optimizing feed (or energy) intake to dilute maintenance requirements has been the primary reason for feeding cattle ad libitum in the past; however, while diluting maintenance, this may not be maximizing profits. Feed efficiency is a two part equation dictated by average daily gain and feed intake. Slightly restricting intake (see Felix, 2015) actually increased cattle efficiency over ad libitum fed controls in multiple studies (Plegge, 1987; Hicks et al., 1990). These subtle nuisances in grain feeding strategy have only become apparent in the last 30 years; and, as with many things, tradition prevails in the cattle industry and the majority of cattle are still fed ad libitum. The primary reasons that ad libitum feeding continues to persist in the cattle industry is that: 1) ad libitum feeding maximizes energy intake, and 2) ad libitum feeding requires very little management experience. The initial comparisons of grain feeding were made relative to cattle on pasture for these same reasons, pasture was easier, and required less labor, than grain feeding, and are applicable in Brazilian systems as well.

That said, one of the predominant reasons for the rapid growth and acceptance of corn-based diets for finishing beef cattle in the U.S., and the rapid growth of these grain-based systems in Brazil, was the efficiency of production. According to the NRC (2000), the energy values for corn are 88% TDN, 2.18 Mcal NE_m/kg and 1.5 Mcal NE_g/kg. This is tremendous when compared to the relative energy value of common U.S. grass and legume mixed pasture (53-79% TDN; 1.00-1.91 Mcal NE_m/kg; 0.52-1.27 Mcal NE_g/kg) or to Brachiara Brizanthan Grass (54.8% TDN; BR-Corte, 2016) and makes it easy to see why corn was promoted for use as an energy source early on.

The differences in energy contribution from corn and forage alters the growth performance of cattle. In cattle fed predominantly forage, or grazed on pasture, typical average daily gains (ADG) rarely exceed 1 kg. However, cattle fed corn-based diets may gain up to 2 kg per day. These gains ultimately affect feed efficiencies. Cattle finished on pasture typically convert forage to gain at a ratio of 12:1 that is 12 units of feed for every units of gain. Whereas cattle fed grain based diets can usually achieve much better efficiencies. These improvement lead to less time on feed and a reduction in the use of other natural resources (i.e. water, land, etc.), thus, improving the sustainability of beef cattle production systems (Capper, 2011).

Shifts in cattle growth performance largely occur due to shifts in ruminal fermentation parameters. There are three main volatile fatty acids that are produced in the rumen: acetate, propionate, and butyrate. Referred to as VFAs, these acids supply approximately 80% of the energy needs of cattle. In general, acetate makes up 50 to 70% of the total molar proportion of ruminal VFAs whereas propionate makes up 20 to 40% and butyrate makes up 5 to 15%. The range in molar proportions is affected by the diet fed. If the diet contains more forage, then acetate production will be favored in the rumen. Whereas, if the diet contains more grains, then propionate production will be favored in the rumen.

Of the three main VFAs, the production of propionate is a most energetically favorable pathway in the rumen because propionate is the main precursor to glucose for cattle. Because of this, shifting to greater proportions of propionate production in the rumen will increase cattle feed efficiencies. Typically these shifts in fermentation are monitored by comparing the acetate to propionate ratios in the rumen. When cattle are fed forage-based diets the acetate to propionate ratio is ~4:1; however, when cattle are fed grain or corn-based diets, the acetate to propionate ratio drops to 2:1 (Van Soest, 1994). Thus, feeding grain increases cattle efficiency by increasing the production of propionate, the more energetically efficient pathway in the rumen.

Meat Quality

In addition to increasing energetic efficiency, propionate production can affect meat quality. Meat quality is important to beef palatability and acceptance, and, therefore must also be considered with animal performance. In the U.S., beef cattle are marketed on a grid made of up of yield and quality grades assigned by a trained grader. Marbling, is one of the main drivers of quality grade, and, as such, is one of the criteria used for pricing in the U.S. Increasing propionate, relative to acetate, shifts fat deposition to intramuscular cells, those found in the muscles, which increases the marbling (Smith and Crouse, 1984) as opposed to subcutaneous fat deposition, that found just under the hide (Wan et al., 2009). Increased marbling can affect sensory, consumer acceptance, data with regards to beef (e.g. there is a correlation between marbling and perceived tenderness; Canozzi, 2016).

In spite of the production and quality responses, acceptance of beef from cattle fed grain was initially a concern in the U.S. (Corah, 2008). Sensory data are data collected on the tenderness, juiciness, and flavor of beef and are determined by trained sensory panels. Sensory data now suggests that, overall, consumers in the U.S. prefer beef from cattle fed corn when compared to beef from cattle fed forage, or grazed. Most often, the biggest negative that consumers identify when presented with grass-fed beef is that it is less tender than grain-fed beef, whereas juiciness is usually equal (Van Elswyk and McNeill, 2014). Data on flavor has been variable and this likely results from changing seasons and forage species affecting the fatty acid profile (and, thus, the flavor) of grass-fed beef whereas beef from cattle fed grain has a very consistent flavor profile (Duckett et al., 2013).

Many of the meat quality responses, however, are confounded by the age of animals at harvest. Due to the difference in growth performance, cattle finished on grain are often harvested at a younger age than cattle fed forage their entire lives. Increasing animal age, decreases the tenderness of meat. In addition, increasing average daily gain has been shown to increase tenderness (Shackelford et al., 1994; Smith et al., 2007), again supporting the increasing tenderness of beef from cattle fed grain. However, the correlation between cattle diet, rate of gain, and age, and even breed (Canozzi et al., 2016), is often a confounding factor when discussing tenderness of beef and, therefore, must be discussed with some caution.

Despite all these difference, beef cattle still ~70% of their lives on pasture, even in the typical “corn-based” U.S. beef production systems. Meanwhile, those calves finished on grain spend only 120 to 150 days consuming grain on averaged. In a recent study, the Nobel Foundation compared the amount of grain fed to various livestock species: cattle, swine, and poultry (Coffey, 2011). Although feed conversions are 2:5 to 1 in poultry and 3.5 to 1 in swine, they may be as great as 6 or 7 to 1 in beef cattle. However, due to the beef spending the majority of their life on pasture, Coffey (2011) points out that the amount of grain per TOTAL units of BW in beef when comparing the entire lifecycle is just 2.5, similar to the amount required by poultry and less grain than swine. This subtle shift in the latter part of the calves life has afforded beef producers in the U.S. to increase the amount of beef produced per cow in the U.S. has by 130 kg in just the last 30 yrs. Increases in total beef production have happened even in the face of some declining cow-herd numbers as well.

Conclusions

As an industry, beef producers have the advantage of using a feedstuffs that no other production livestock industry can, pasture. However, making use of that cheap and available feed resource has put the beef industry at a disadvantage from an efficiency of growth standpoint when compared to poultry or swine production. Feeding cattle grain-based diets in the latter part of life (prior to slaughter), increases growth and improves meat quality attributes such as marbling deposition and tenderness. These improvements in efficiency can help reduce the total cost inputs in a beef system.

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