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REVIEW

REVIEW: Traditional and alternative sources of fiber—Roughage values, effectiveness, and levels in starting and finishing diets[1]

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ABSTRACT

Roughage plays a vital role in ruminant diets. This review considered the effects of roughage in diets for newly received cattle, the physical and physiological effects of roughage in feedlot cattle diets, the use of NDF as a means of assessing the roughage value for feedlot cattle, and potential alternatives to traditional roughages and roughage feeding practices. In newly received, stressed cattle, a meta-analysis from trials conducted at a single location indicated that receiving period morbidity (percentage of cattle pulled and treated for bovine respiratory disease) decreased slightly as roughage level increased. Nonetheless, increasing roughage level decreased receiving period ADG and G:F; therefore, unless cattle are able to compensate at later stages of the feeding period, the small decrease in morbidity with added roughage might be offset by decreased performance. For growing-finishing cattle, a meta-analysis indicated that intakes of DM and NE_g increased linearly as dietary NDF concentration increased over a range of approximately 7.5 to 35% NDF. Both roughage and total dietary NDF were effective for determining the relative value of different roughage sources to achieve equal DMI in beef feedlot diets. Fiber in by-product feeds, such as wet corn gluten feed and distillers grains, dilute grain starch and might have the ability to substitute, in part, for traditional roughage; however, NDF concentration of these by-products is not an effective measure of roughage equivalency. Altering methods of roughage delivery, such as feeding a lower level of dietary roughage with intermittent delivery of additional dietary roughage or coarser forms of roughages that stimulate chewing or alter digesta passage rate, might provide a means of decreasing overall roughage use without compromising animal health and performance, but research is needed to test the merits of these approaches. Significant research questions remain to be addressed before we fully understand the chemical, physiological, and physical roles of roughage in feedlot diets.

Key words: feedlot cattle, morbidity, neutral detergent fiber, roughage level, roughage source

INTRODUCTION

Cattle consume roughage from a variety of sources throughout their lives. Indeed, consuming roughage is generally required for cattle to ruminate, which is a characteristic feature of the family *Bovidae* and other families of the order *Ruminantia*. Typically, beef calves are familiar with roughage, so when they are weaned and marketed, providing long-stemmed roughage is a common practice to encourage intake. Once cattle are in feedlots, including a small percentage of roughage in high-grain finishing diets helps to prevent digestive disorders such as acidosis and to maximize NE intake. In their survey of 29 nutritional consultants located in the major US cattle-feeding areas, Vasconcelos and Galyean (2007) reported that among

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consultants responding, roughage level of finishing diets ranged from 0 to 13% (DM basis), averaging 8.3 and 9% roughage in summer and winter, respectively. Corn silage and alfalfa hay were the most common roughage sources noted in the survey. Both source and level of roughage affect DMI by feedlot cattle (Defoor et al., 2002), thereby ultimately affecting ADG and G:F.

Recent drought conditions in the High Plains cattle-feeding region of the United States and associated low supplies of traditional roughage sources have renewed interest among feedlot cattle producers to understand methods of effectively substituting 1 roughage source for another, to establish criteria for selecting the optimal roughage level in diets for newly received cattle being adapted to the feedlot, and to decrease levels of roughage in finishing diets. In the current review, we will address approaches for selection of roughage sources and levels in each of these production situations, as well as potential alternatives to traditional roughages and roughage-feeding practices. This discussion will be framed within the context of the physical and physiological effects of roughages on the ruminant digestive tract.

ROUGHAGE IN DIETS OF NEWLY RECEIVED CATTLE

Weaning and shipping cattle to alternative locations where they will either graze or start a feedlot-based growing and finishing program is still a normal part of the beef cattle-marketing system. The multiple natures of these activities are critical to subsequent cattle health and performance. Bovine respiratory disease complex (**BRD**) is commonly associated with marketing of newly weaned, lightweight cattle, and the accompanying stressful conditions of weaning, marketing, and transportation contribute to a greater risk of BRD. Degree of stress, previous plane of nutrition, genetics, and health history interact with exposure to viral and bacterial agents, reflecting the complex nature of BRD (Frank, 1986). Estimates suggest that BRD is responsible for approximately 75% of feedlot cattle morbidity and 50% of mortality (Edwards, 1996). Gardner et al. (1999) reported that steers treated for BRD had lower ADG and HCW, with fewer cattle grading USDA Choice than their nontreated counterparts. More recently, Holland et al. (2010) reported that heifers treated 1 or 2 times for BRD and those classified as chronically ill during a 63-d preconditioning phase had lower BW at the end of the preconditioning phase than heifers that were not treated. Heifers treated 1 or 2 times compensated during the finishing period, such that days on feed did not differ from heifers that were not treated. In contrast, heifers treated 3 times required more days on feed to reach an equal BW to heifers treated 0, 1, or 2 times, but even with additional days on feed, chronically ill heifers had lower final BW than those in the other groups. These results suggest that except for heifers treated 3 times and those classified as chronically ill, most of the negative effect of BRD on performance occurred during the receiving period.

Nutritional management of stressed cattle is important because it can help provide calves the resources needed to mount a robust immune response against pathogens associated with BRD. Galyean et al. (1999) and Duff and Galyean (2007) reviewed the role of various nutritional supplements and management practices in mitigating the effects of BRD. It is clear from their reviews that dietary energy is an important factor affecting how beef cattle respond to a BRD challenge. Because health and performance during the receiving period is crucial to the overall economic outcome of cattle feeding (Holland et al., 2010), optimal formulation of receiving diets is critical. Energy content in receiving diets is most often modified by changing roughage level. Starting lightweight, highly stressed cattle on a high-roughage diet is based on the purported advantage of decreasing BRD morbidity and mortality. Conversely, the justification for starting cattle on a diet with more concentrate (less roughage) is an improvement in performance and thereby increased profitability. The challenge is to find the optimal energy level that provides acceptable performance without negatively affecting receiving period morbidity and mortality. Lofgreen (1979) reported that cattle received on a 75% concentrate diet, with or without long-stemmed alfalfa hay during the first week after arrival, had greater ADG and feed intake than cattle started on hay alone; however, Lofgreen et al. (1981) later noted that although the cattle started on hay alone gained less, they tended to have fewer total sick days than calves received on the higher concentrate diets. In agreement with the general findings of those studies, Fluharty and Loerch (1996) reported that as dietary concentrate level increased from 70 to 85% DMI increased but ADG did not; in contrast to Lofgreen et al. (1981), morbidity was not affected by diet. Berry et al. (2004a,b) fed newly received calves diets that were arranged in a 2 × 2 factorial (2 energy and 2 starch levels) in an effort to determine whether changes in energy per se or starch level were the primary factors affecting performance and health. Dietary energy level did not affect performance or overall morbidity, but prevalence of BRD pathogens in nasal swabs of morbid calves was altered in response to energy level, regardless of the starch level.

Rivera et al. (2005) used mixed-model regression methods to analyze data from 6 experiments conducted by Glen Lofgreen at the New Mexico State University Clayton Livestock Research Center (**CLRC**; Clatyon, NM). The primary objective of these trials was to evaluate the relationship between dietary roughage level (DM basis) and receiving period morbidity, ADG, and DMI. Data from specific experiments used in their analyses were taken from various CLRC Progress Reports and are listed by Rivera et al. (2005). Morbidity from BRD decreased slightly as dietary roughage level increased (morbidity, % = 49.59 – 0.0675 × roughage, %; $P = 0.003$).