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Effective Fiber in Beef Cattle Diets

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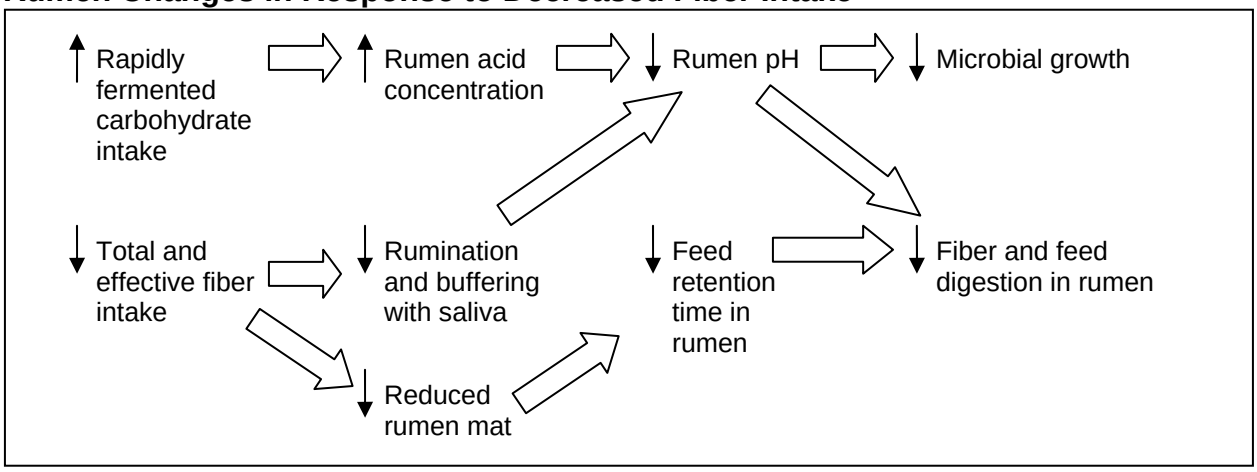
While energy and protein are often the major focus of many beef cattle nutritional programs, fiber is another essential diet component that is receiving lots of attention this year. Fiber type, quality, and length impact cattle health and productivity. With hay shortages commonplace on Mississippi beef operations over the winter, producers have had to consider alternative roughage sources for cattle nutritional programs. Effective fiber levels are typically not a concern in beef cattle on high forage diets, such as when grazing with sufficient available forage or with free-choice hay supplementation. However, in periods of hay and grazing shortages, effective use of fiber substitutes in beef cattle diets becomes critical.

What is Fiber?
Fiber can be defined as carbohydrates that are not digested by mammalian enzymes but can potentially be digested by rumen microorganisms. Fiber includes cellulose, hemicellulose, lignin, and soluble fiber (fructans, pectans, galactans, and B-glucans). Fiber in plant material is in the structural components of cell walls. In the rumen, fiber-digesting bacteria digest fiber (structural carbohydrates), while starch-digesting bacteria digest starch (nonstructural carbohydrates). In general, the starch digesters tolerate low pH levels, but the fiber digesters are inhibited by low pH. If the goal is to maximize forage intake and digestibility, then it may be counterproductive to add grain (corn, wheat, etc.) to the diet of cattle beyond a threshold of about 0.5% of body weight because of reduced rumen pH effects. A supplement with low levels of starch and highly digestible fiber (soybean hulls, corn gluten feed, dried distillers' grains) is more appropriate to maintain forage intake, digestibility, and rumen pH. Rumen pH can also be buffered or kept from going too low by buffers produced in the animal's saliva. Salivary flow is primarily stimulated during rumination (chewing of the cud) by effective fiber.

Beef cattle diets deficient in fiber can cause permanent damage to the rumen wall. The effectiveness of fiber for supporting rumen health is positively related to particle size of feeds containing the fiber and is referred to as effective fiber. A high level of fiber in the diet does not always indicate that the diet is adequate in effective fiber. If the fiber is chopped or ground too short or fine it may not be effective in promoting rumen health. A good example of this is soybean hull pellets. Soybean hulls are high in digestible fiber levels and yet have a small particle size and are relatively low in effective fiber levels. Studies show that effective fiber supplementation improves the performance of cattle fed soybean hull pellets. Therefore, soybean hull pellets should not be used as an exclusive fiber source to replace hay. Finely ground fiber will pass through the digestive system rapidly and will not meet the effective fiber requirements of cattle.

Rumen Changes in Response to Decreased Fiber Intake



NDF and ADF

Neutral detergent fiber (NDF) is commonly noted on forage test results, refers to fiber that is insoluble in neutral detergent, and includes cellulose, hemicellulose, and lignin. Neutral detergent fiber is negatively correlated with dry matter intake. As NDF increases in the diet, dry matter intake decreases. Likewise, acid detergent fiber (ADF), the portion of fiber that is insoluble in acid detergent (cellulose and lignin) is negatively correlated with digestibility. As ADF increases, forages or feeds become less digestible. Both NDF and ADF increase as forages mature.

Effective Fiber

Effective fiber is estimated by effective NDF (eNDF). Effective NDF refers to the percentage of the NDF effective in stimulating chewing and salivation, rumination, and rumen motility (Beef Cattle NRC 7th edition, 2000 Update). The importance of stimulating salivary flow to buffer rumen pH is well documented. Dietary levels of eNDF impact rumen pH and are often used to predict rumen pH in feeding formulations. Sufficient eNDF levels are important in beef cattle diets to keep rumen pH from dropping below acceptable levels to maintain feed intake levels. Diets high in grains (high starch diets) will often reduce rumen pH. However, highly digestible feeds that are high in pectins (soybean hulls, beet pulp, etc.) will not produce the dramatic pH drop that many grains produce.

The eNDF required in high energy (e.g., finishing) diets is 8%, which is considered to be the concentration necessary to keep rumen pH above 5.7. A rumen pH below 5.7 dramatically reduces dry matter intake in cattle. If cattle gorge on high starch feeds or there is a lack of effective fiber in the diet leading to inadequate saliva secretion to buffer the rumen, rumen pH can remain low, and intake may drop off at the next feeding. Low pH levels for extended periods of time can shift the microbial population to favor bacteria that produce high levels of lactic acid, and then acute acidosis can occur. Cattle changing from high roughage to high concentrate diets need several weeks of gradual adjustment from one diet to the other to allow the development of rumen microbes to digest high starch levels without dropping rumen pH below 5.6.

Estimated eNDF Requirements for Beef Cattle Adjusted to High Grain Diets

Diet Type	Minimum eNDF Required, % of Dry Matter
High concentrate to maximize gain/ feed fed mixed diet, good bunk management, and ionophores	5 to 8[a]
Fed mixed diet, variable bunk management, or no ionophore fed	20
High concentrate to maximize non-fiber carbohydrate use and microbial protein yield	20[b]

[a]To keep rumen pH more than 5.6 to 5.7, the threshold below which cattle stop eating.
[b]To keep rumen pH above 6.2 to maximize cell wall digestion and/or microbial protein yield.
Source: Beef Cattle NRC 7th edition, 2000 Update.

Bunk management can be used to control wide variations in rumen pH and can reduce the eNDF requirement to a minimum of 5% of dietary dry matter. Ionophores (monensin and lasalocid) added to the feed or mineral supplement can also reduce the quantity of feed that cattle consume at one meal and result in less rumen pH fluctuation. Under low rumen pH conditions (pH < 6), very little energy will be derived from the fiber in forages consumed and microbial protein yield will be reduced by at least one-third. Depending on feeding management, as much as 25% eNDF may be needed to maintain adequate pH for maximum forage digestion and microbial growth. Effective NDF levels that are too low can result in high passage rates and lower net energy values. Effective fiber levels can be increased by course instead of fine chopping of forages or adding feeds higher in effective fiber levels.

Effective NDF Values of Common Beef Cattle Feeds

Feed	NDF, % of dry matter	eNDF, % of NDF[a]
Cottonseed hulls	90.0	100
Whole cottonseed	51.6	100
Bahiagrass hay	72.0	98
Bermudagrass, late vegetative	76.6	98
Tall fescue, mature	70.0	98
Mature corn silage, normal chop	41.0	71
Mature corn silage, fine chop	41.0	61
Corn gluten feed	36.2	36
Cottonseed meal	28.0	36
Corn, dried grain	9.0	60
Corn, cracked	10.8	30
Soybean meal	7.8	23
Hominy feed	23.0	9
Distillers grains with solubles	46.0	4
Soybean hulls	66.3	2
Wheat middlings	35.0	2

[a]Equals the proportion of NDF that is effective in stimulating rumination, and is defined as the percent remaining on a 1.18 mm screen after dry sieving.
Source: Beef Cattle NRC 7th edition, 2000 Update.

The eNDF in a feed or forage varies with the size of feed particles. Larger feed or forage particles are more effective in causing abrasive actions in the rumen often referred to as “scratch factor”. Effective NDF levels drop from 98% of NDF with long grasses to 73% of NDF with grasses less than ¼” length. In legumes eNDF levels drop from 92% of NDF with long legumes to 67% of NDF with legumes less than ¼” length. Therefore, feeding recommendations will often specify a minimum forage staple length to ensure good rumen health. Reviewing the NDF and eNDF levels of common feedstuffs reveals why many “hay replacer” rations will contain large percentages of cottonseed hulls. Cottonseed hulls are an excellent roughage and effective fiber source for beef cattle diets.

Planning ahead for acquiring adequate roughage supplies can provide cattle producers with more nutrition program options when feed or forage supplies become tight or expensive. Producers should factor effective fiber needs into decisions on appropriate fiber substitutes in hay replacement programs. For more information on beef cattle nutrition, contact your local Extension office.