ROLE OF ALFALFA IN ANIMAL DIETS

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Introduction

Alfalfa forage use has increased in all classes of livestock - dairy, beef, horses, sheep, and swine - during the last 40 years. The highest utilization of alfalfa by livestock is found in dairy cattle diets. Additionally, the use of alfalfa as a grazing crop has also undergone a considerable increase with the use of new grazing management techniques and the development of new grazing varieties.

Alfalfa's strength as a forage crop is its high nutritional value. Alfalfa is higher in protein, minerals, and net energy than grasses and small grains. High quality alfalfa also helps to promote intake, especially as long-stemmed hay, because of its influence on increasing saliva flow.

Defining Quality

What constitutes "high quality" alfalfa? Alfalfa that is low in fiber and high in protein content would be considered high quality by most dairy producers. Fiber content and composition has the greatest influence on intake and digestibility of a forage.

A minimum fiber content is required by lactating cows to promote chewing and rumination, rumen health and pH (above 6.2), and in turn, maintain normal milk fat test. If fiber level is too high due to inclusion of overmature forages in the diet, intake will be reduced, consequently, milk production will be lowered.

Neutral detergent fiber (NDF) and acid detergent fiber (ADF) are the primary chemical measurements used to reflect forage quality. Crude protein is important, yet supplemental protein can be obtained easily from other sources; whereas, the digestible energy, ruminal buffering and intake potential of forages cannot be effectively replaced by nonforage supplements. The recommended minimum fiber levels and energy content of diets of high-producing cows is presented in Table 1.

Importance of Alfalfa Fiber

Forage quality is a reflection of the intake potential and digestibility of a forage. Although alfalfa is often lauded for its high protein content, its quality in dairy and beef rations is reflected in its digestible fiber content. Figure 1 depicts why the fiber content is important to the structure of the plant. In order to determine the digestible fiber content, one

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must properly sample the forage and submit the sample to a certified forage testing laboratory. A request for dry matter (DM), acid detergent fiber (ADF), neutral detergent fiber (NDF), and net energy (NE) are needed for determining quality. A request for crude protein (CP) will reflect nutritive quality, but it will not reflect the intake potential or digestibility of the forage.

The NDF content, in general, reflects the intake potential of a forage. It is an estimate of the amount of the structural carbohydrate of the plant, including the cellulose, hemicellulose, and lignin. These components occupy space in the rumen and are generally slowly digested in the rumen. The slowed digestion rate, decreased rate of passage, and delayed emptying of the rumen are contributors to the decreased intake of forages high in NDF.

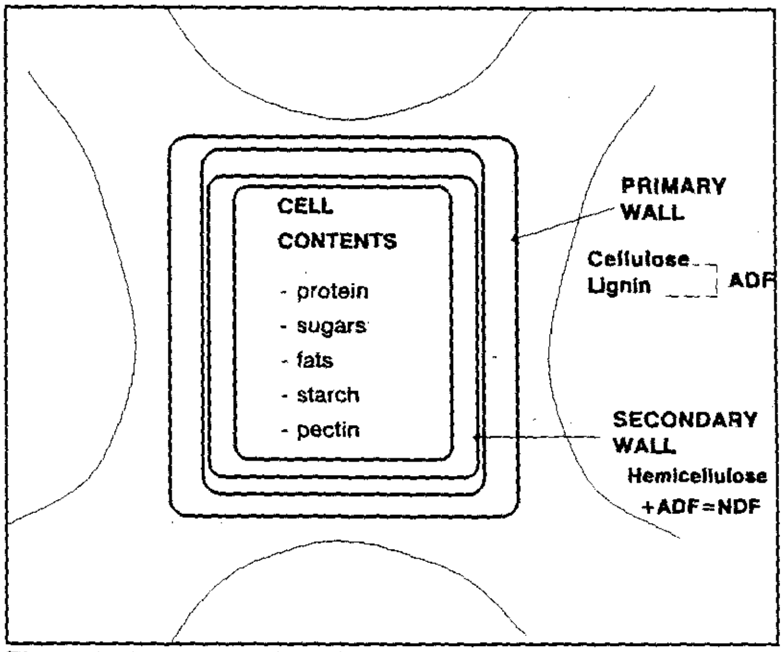

Figure 1. Plant cell wall depicting structures which include ADF, NDF and proteins.

The ADF measurement estimates the amount of cellulose and lignin in the plant. ADF is a better indicator of digestibility than NDF. Most laboratories also predict the energy values of forages from ADF. The accuracy of these predictions have been questioned since few equations account for more than 60 % of the variation in energy content of individual forages (Allen, 1993). NDF should be used as the major index for monitoring minimum dietary levels of fibrous carbohydrates because ADF excludes the structural carbohydrate, hemicellulose. However, ADF is more reflective of functional fiber when a major portion of the total fiber in a ration is being contributed from nonforage sources (which tend to be higher in NDF but lower in ADF compared to forages).

An immature alfalfa plant is considered "high-quality" because it usually contains less than 30% and 40% of the forage dry matter as ADF and NDF, respectively. The lower the ADF content, the more digestible the forage and the higher the estimated energy value. The lower the NDF, the lower the rumen fill, thus the greater the intake potential. The recommended minimum dietary ADF and NDF, presented in Table 1, are specific to dairy rations.

Poor quality alfalfa which contains high levels of ADF and NDF cannot be used effectively to formulate diets for high production. Table 2 reflects the amount of forage, varying in quality, that can be added to a diet when the recommended minimum 21 % forage NDF is desired. As shown, if the NDF is greater than 50, then the allowable level of that forage in the diet is less than 40 percent of the dry matter. When forage dry matter falls below 40 % of the diet, the potential for depressed intake, displaced abomasums, ruminal acidosis, depressed milk fat production, and other health problems are greatly increased. Additionally, in a diet in which the legume NDF is greater than 50, energy and protein intake is usually limited because of the low digestibilities of low quality legumes.

Table 1. Recommended minimum fiber levels and energy content of diets of high-producing cows.

Fiber measurement	Percent
ADF, % DM minimum	19-21
NDF, % DM minimum	27-30
Forage NDF, % DM minimum	21-22
% NDF as forage	75
% forage in diet, minimum	40
Net energy of lactation, Mcal/lb	.78

Adapted from NRC, 1989.

Table 2. Effect of forage NDF level on percent forage allowed in dietary dry matter when providing a minimum 21 % NDF from forage in dairy cow diets.

Legume Forage NDF %	% Forage allowed in Dietary DM
35	60
40	52.5
45	46.7
50	42
55	38
60	35

[a] Adapted from Shaver, 1989.
[b] Calculation: (21% NDF from forage/35% NDF in legume) x 100 = 60% forage in dietary DM
[c] Potentially unhealthy to rumen environment since less than 40 % of dietary DM as forage.

In beef cattle diets, one can use the following equation for predicting the potential NDF intake: NDF intake = 1.2% of BW. With a high level of NDF, the rumen retains the forage for a longer time, thus the desire to eat at several intervals is much less.If the forage delivered to the beef animal is excessively high in NDF (mature), then based on this equation, the animal will fill up at 1.2% of its BW, a level reached before nutrient requirements are met.

Just how slow, or fast, a forage containing high levels of NDF degraded in the rumen? The rate of ruminal fiber degradation is less easily measured than the quantification of ADF and NDF, yet it is important to consider for promoting forage intake. The higher the quality, the faster the rate of digestion, the greater the potential intake. The maturity of the forage directly influences the rate of degradation. Degradable NDF in alfalfa (Table 3) in the bud stage degraded at a rate of .098 per hour; whereas, the NDF in late bloom alfalfa degraded more slowly at .077 per hour. The mature alfalfa would stay in the rumen longer, taking up space, thus intake potential of this forage is lower than the immature alfalfa.

Table 3. Digestion characteristics of NDF in alfalfa hay cut on the same date.[a]

Days after prebud	Stage of maturity	Crude Protein	NDF[b]	INDF[c]	DNDF[d]	DNDF Rate (per hour)
		---------% of DM---------				
0	prebud	24.5	35.8	14.9	20.9	0.103
7	bud	21.9	40.0	17.4	22.6	0.098
14	early bloom	19.6	43.7	19.8	23.9	0.093
21	midbloom	17.6	46.9	22.1	24.8	0.088
28	full bloom	16.0	49.5	24.4	25.1	0.082
35	late bloom	14.6	51.6	26.6	25.0	0.077
42	post bloom	13.6	53.2	28.7	24.5	0.071
49	mature	12.9	54.2	30.7	23.5	0.066

[a]Adapted from Mertens, 1988.
[b]Neutral detergent fiber.
[c]Indigestible neutral detergent fiber.
[d]Digestible neutral detergent fiber.

Importance of Alfalfa Protein

Traditionally, alfalfa has been valued for its high protein content. By providing high levels of protein from a legume, such as alfalfa, a producer is required to purchase less costly protein supplement for the dairy, beef or horse operation. As an example, if a beef producer purchased alfalfa hay containing 19.2% CP and 61.2% TDN to feed to her growing beef steers (500 lb, medium framed), she would not need to purchase additional protein to supplement her steers. Why? Because her steers require 14.0% CP in order to reach her designated goal of 2.0 lb. average daily gain. She would need additional grain supplementation in order to achieve the 68% TDN requirement for this level of gain. A similar case could be made for someone raising dairy heifers at a similar weight and gain.

In diets for high producing dairy cows, alfalfa is also a very important protein source. However, if the predominate protein source is high quality alfalfa silage, then protein may be the first-limiting nutrient. Researchers from Wisconsin (Table 4) conducted a series of studies evaluating performance of high producing cows consuming diets containing 75% of DM as high quality alfalfa silage. Although the crude protein requirement for lactation was met without additional protein supplementation, the addition of protein (fishmeal + bloodmeal) to the diets illicited a milk production response. These data indicate that excess soluble and degradable protein in the rumen, beyond the ruminal microbes requirements, will not necessarily provide the optimum level of amino acids to the small intestine. Provision of additional amino acids through an animal source of bypass protein, such as fishmeal and bloodmeal, will likely improve the animals protein utilization for milk production.

Table 4. Treatment effects on DM intake, weight gain, and milk production in cows consuming diets containing 75% of dietary DM as high quality alfalfa silage.

Item	Control	Protein	Fat	Protein + Fat	Protein +Glucose	SEM
DM Intake, lb	48.4[b]	55.9[a]	49.5[b]	52.1[ab]	42.5[c]	5.0
BW Gain, lb	50.6	48.4	33.0	61.0	59.4	26.4
3.5% FCM, lb	63.4[c]	75.0[a]	67.5[bc]	71.7[ab]	68.4[bc]	2.2
Milk Protein, lb	1.89[b]	2.29[a]	1.94[b]	2.18[a]	2.20[a]	.07

[abc]Means in same row with different superscripts differ ($P<.01$).
Adapted from Dhiman and Satter, 1993.

Rumen Stability

In reality, whenever we provide feed to ruminants, we are not feeding the animal, but instead, are feeding its rumen microorganisms. As long as adequate substrates are being provided to these microorganisms, then the animal will maintain a healthy appetite and be productive. However, if the microorganisms are improperly fed, the animal's desire to eat will be disturbed, thus production and health will decline. One of the primary goal's of proper feeding management is to provide a stable rumen environment.

Maintaining a stable rumen environment is greatly dependent on the feeding system. A consistent flow of feedstuffs into and out of the rumen helps to maintain stability. Feeding grain and forages separately disrupts this stability. However, if grain is fed several times a day, the ruminal stability improves because the "slugging" of grain is lessened. Some nutritionists recommend feeding hay before grain so that the rumen is "buffered" before the grain arrives. The long forage would provide a more dense rumen mat so that when the grain enters the rumen, it will remain longer for more complete fermentation of all the feeds present. The rumen can also become "unstable" if the particles of the forage are all less than 2" long. These short, lightweight particles will not provide an adequate mat to retain the feeds in the rumen for adequate fermentation.

The increasing use of total mixed rations (TMR) primarily in dairy operations, but also in beef and horse feeding regimes, has helped to improve ruminal stability because each bite contains a balance of forage and concentrate. Additionally, free-choice feeding of TMR's allow cows to consume several meals during the day. Particle size of a TMR is very important for effectiveness of fiber and for minimizing sorting by the cows. Feeds in a TMR should not be overmixed because it will result in a reduction of particle size resulting in poor effectiveness ("scratch factor") of the fiber. Bunk space should also be considered. Allowing 24" per mature cow should allow for optimal intakes of forage and concentrate.

Indicators of Rumen Instability

A decrease in dry matter intake, low milk fat test, less than 30% of cows chewing the cud, ketosis, laminitis, sole hemorrhages, and displaced abomasums are all indicators of rumen instability. When ruminal pH declines as a result of overfeeding grain or not providing enough effective fiber, the cow responds by decreasing intake until the rumen stabilizes, and this cycle continues, resulting in irregular intakes from day to day. In turn, the level of milk in the tank fluctuates as well. When incidence of clinical health problems exceed typical levels, prompt attention to dietary fiber and nonstructural carbohydrate levels and feeding practices must occur. By simply adding long-stemmed hay to diets of animals at the first sign of being off-feed, or after two consecutive low butterfat tests, one can prevent serious clinical health problems in the ruminant animal.

Selected References

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