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Calf Note #156 – How much roughage for calves?

Introduction

Feeding roughage to calves often spurs debate among calf raisers. Some argue that including some roughage in the diet is important to rumen health and growth while others point to data that suggests that calves grow well with little or no dietary roughage. The subject of this Calf Note is to review some recent data regarding forage feeding to young, weaned calves.

Researchers at the Akey Nutrition and Research Center conducted four trials to evaluate graded levels of roughage in diets of weaned calves (Hill et al., 2010). Holstein steer calves were 8 weeks of age at the start of each 56-day study.

Calves in each study were fed a common calf grower diet containing 20% CP and 12% NDF. The grower was based on whole corn, whole oats and a protein pellet with soybean meal as protein source. Calves were fed 0, 3, 6 or 9% chopped wheat straw (trial 1); 0, 5, 10 or 15% long alfalfa hay (trial 2); 0, 3, 6 or 9% chopped grass hay (trial 3); or 7.5% of the diet as long or chopped alfalfa hay (trial 4). Average daily BW gain and hip width change declined as amount of roughage in the diet increased.

Clearly, in these trials, increasing amount of roughage had a negative effect on growth. Others (e.g., Hill et al., 2009) suggest that little, if any, forage is required. Increasing amounts of roughage in the diet also contributes to gut fill, which makes it more difficult to determine exactly whether increased BW is increased

body tissue or increased weight of undigested residue in the stomach and intestines. Stobo et al. (1966) reported increased gut fill and lower actual BW gain with increasing amounts of roughage in

Nutrient	Treatment				P
	A	B	C	D	
Trial 1	0%	3%	6%	9%	
ADG, kg	1.27	1.10	0.96	0.89	L
E-ADG, kg	1.19	1.02	0.87	0.79	L
DMI, kg/d	3.49	3.54	2.97	2.81	L
HWC, cm	6.7	6.2	5.9	5.4	L
Trial 2	0%	5%	10%	15%	
ADG, kg	1.21	1.21	1.14	1.07	L
E-ADG, kg	1.14	1.13	1.06	0.98	L
DMI, kg/d	3.63	3.62	3.53	3.58	NS
HWC, cm	6.2	6.4	6.0	5.7	L
Trial 3	0%	3%	6%	9%	
ADG, kg	1.18	1.24	1.17	1.09	L,Q
E-ADG, kg	1.11	1.15	1.08	0.99	L,Q
DMI, kg/d	3.98	4.34	4.20	3.83	Q
HWC, cm	5.9	6.3	6.0	5.8	L
Trial 4	Chopped	Long			
ADG, kg	1.17	1.15			NS
E-ADG, kg	1.09	1.17			NS
DMI, kg/d	3.35	3.20			0.10
HWC, cm	5.8	5.9			NS

Table 1. Effect of increasing amount of roughage (trials 1-3) or 7.5% of ration as chopped or long forage (trial 4) on ADG and DMI in calves after weaning. From: Hill et al. (2010).

Probability: L = linear effect, $P < 0.05$; Q = quadratic, $P < 0.05$, NS = not significant, $P > 0.10$.

E-ADG = ADG calculated on empty body weight basis (to remove effects of gut fill). HWC = hip width change (from beginning to end of study).

the diet of young, preweaned calves. A lot of research data suggests that calves don't have a requirement for roughage in the diet *per se*, if the starter is properly formulated, manufactured and fed (Kertz, 2005).

Well, there are some data that suggest some hay can be good for calves. For example, Coverdale et al. (2004) reported improved performance of calves fed up to 15% of the DM as forage. McGavin and Morrill (1976) showed clearly that high grain diets can affect anatomical development of the rumen. Their landmark study revealed dramatic changes (damage) to the ultrastructure of rumen papillae caused by excess dietary carbohydrate. Hinders and Owen (1965) also reported that high grain, low forage diets can contribute to development of parakeratosis in steers. Thus, the concept of excess ruminal fermentation and ruminal problems seems to be a real concern. The key question may be not one of whether forage is necessary or not, but rather can a starter be formulated in such a way to minimize the risk of developing ruminal parakeratosis. In the study by Hill et al. (2010), the presence of whole grains (corn, oats) and the low amount of rapidly fermentable sugars probably reduced rates of ruminal fermentation. In addition, diets were well managed and available for ad libitum consumption. Water was available at all times. These management factors contribute to regular intake and smaller meals, which can also reduce the risk of rumen problems.

Roughage can be important to maintaining a normal, healthy rumen environment. When calves (or cows) consume hay, large particles float on the top of rumen liquid, forming a "mat" of hay that effectively strains incoming feed. This mat helps stabilize the rumen from large "slugs" of concentrate and helps promote cud chewing, salivation and maintenance of normal rumen pH. In the absence of forage, no mat is formed and the rumen contents can take the consistency of oatmeal. High rates of fermentation and buildup of acids (especially propionic and butyric acids) can cause excessive growth of the rumen papillae. In addition, the lack of fiber may impair removal of keratin from the outside of the papillae, causing them to clump together. So, seemingly, having some forage in the diet would be very helpful and promote greater intake and growth. Why, then, do we see some studies showing reduction in growth with increasing forage in the diet?

The answer relates to energy. When we replace concentrate (corn, oats, soybean) with forage – even good forage – we dilute the energy in the diet. Table 2 shows the difference in ME and NDF in typical concentrate ingredients vs. forages. Clearly, as we increase forage in the diet, we reduce energy and increase fiber. Limiting ME available will reduce growth and development of frame size.

Ingredient	ME, Mcal/kg	CP, % of DM	NDF, % of DM
Corn, ground	3.12	9.4	9.5
Oats, rolled	2.78	13.2	30.0
Soybean meal, 48%	3.41	53.8	9.8
Grass hay, mid mature	2.02	13.3	57.7
Legume hay	2.09	20.8	42.9

Table 2. Nutrient content of selected concentrate and roughage ingredients. Source: 2001 NRC.

The rumen of just weaned calves is still relatively small and rumen fermentation may not be fully functional. Thus, increasing dietary fiber could slow the rate of fermentation to the point at which the calf becomes limited in ME. This slows growth. The concept of physical fill (too much

undigested residue in the stomach and intestines) limiting intake is a significant problem in calves fed too much fiber.

There appears to be an important balance between energy in the ration and amount of fiber. That is, if the concentrate contains ingredients that are rapidly fermented in the rumen to produce large amounts of acids in a short time, then the value of hay in the ration is increased. Feed management can also be such that calves tend to eat rapidly which can exacerbate the problem of low ruminal pH. On the other hand, ingredients not rapidly fermented in the rumen, or which can contribute some dietary fiber will slow the rate of ruminal fermentation and reduce the importance of forage in the diet.

In the studies conducted by Hill et al. (2010), the main carbohydrate ingredients in the diet were whole corn and whole oats. A comparison of this grower diet with that of Coverdale et al. (2004) is in Table 3. It's possible that the feeds fed by Coverdale et al. (2004) were more rapidly fermented in the rumen. Their diets contained more molasses and wheat middlings, two ingredients rapidly fermented in the rumen. Grinding also increases rate of fermentation of

Ingredient	Hill	Coverdale whole	Coverdale ground
Corn, whole	37.0	31.9	...
Corn, ground	31.9
Oats, whole	25.0	10.0	...
Oats, ground	10.0
Molasses	3.0	8.0	8.0
Pellet			
Soybean meal	23.8	20.5	20.5
Wheat middlings	5.6	16.5	16.5
Soybean hulls	...	5.0	5.0
Other	5.6	8.1	8.1

Table 3. Ingredient composition of calf feeds fed in trials of Hill et al. (2010) and Coverdale et al. (2004).

carbohydrate in the rumen; thus the ground diet would be more rapidly fermented and change rumen VFA production, pH and other indices of rumen health. Indeed, concentrations of VFA in the rumen of calves fed the ground diet were greater than the whole diet in the study by Coverdale. Adding 15% grass hay to the whole diet reduced amounts of VFA in the rumen, suggesting that the forage slowed fermentation and potentially reduced the risk of digestive upset caused by large spikes in rumen acid.

In the end, the need for roughage probably depends more on the rest of the diet and management factors on the farm. Well formulated and well managed starter programs don't require additional forage to optimize calf growth. Others may require it. Like many aspects of calf raising, there's no "one size fits all" answer to this on-going debate.

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