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Calf Note #275 - Forage versus concentrates for calves

Introduction

The process of rumen development and preparing calves for weaning is critically important to calves. Improper preparation prior to weaning can lead to increased stress, poor digestion, low post-weaning growth, and increased risk of disease. So, getting this process right is essential.

Since the late 1940's, we've known that the key driver of rumen development—specifically the ability of the rumen to ferment, absorb, and metabolize ingested feedstuffs—is the fermentation of carbohydrates that produce volatile fatty acids (VFA), particularly propionate and butyrate. Researchers showed that forages such as straw and hay do not produce large amounts of these VFA and, consequently, slow rumen development and preparation for weaning.

This has led to a fundamental approach in calf nutrition: provide non-fiber carbohydrates, such as starch and sugar, that are rapidly fermented to propionate and butyrate to stimulate rumen papillae development.

So, it was with some surprise that a pair of papers published in the Journal of Dairy Science (Poier et al., 2022; Terler et al., 2022) concluded that high-quality forage can completely replace concentrates without negative effects on intake or growth. In fact, several behavioral and metabolic indicators suggested improved animal well-being when calves were fed 100% forage.

Terler et al. (2022) concluded: "*In conclusion, feeding high-quality hay can fully replace starter concentrates in the feeding of dairy calves without adverse effects on performance during the rearing period…*"

So, what's going on? Should we all switch to forage diets for our calves? Let's take a closer look.

The Research

Researchers in Germany fed 40 Holstein calves one of four diets: medium quality hay (MH), high quality hay (HH), 30% MH + 70% calf starter (MH+), or 30% HH + 70% calf starter (HH+). Calves remained on their assigned treatments until 14 weeks of age.

Acidified milk was offered ad libitum through 4 weeks of age, then gradually reduced beginning in week 5, with complete weaning at 12 weeks. Calves were monitored weekly, and intake, growth, behavior, rumen fermentation, and selected metabolic indicators were measured.

Table 1. Composition of feeds.

Item*	Milk	MH	HH	CS
DM	13.0	89.9	88.7	89.1
CP	26.0	14.9	21.0	19.3
EE	3.2	1.8	2.4	1.8
Ash	5.8	7.6	8.6	3.9
NDF	0.0	52.2	45.5	20.4
Lignin	0.0	4.9	2.3	1.3
NFC	0.0	23.5	22.5	54.7
ME	4.6	2.2	2.7	3.2

***Percent of DM, except DM. MH = medium quality hay; HH = high quality hay; CS = calf starter.**

The composition of the feeds (Table 1) shows important differences. The high-quality hay (HH) was not typical hay—it was early-cut English ryegrass, high in crude protein, relatively low in lignin, and contained moderate amounts of non-fiber carbohydrates. In contrast, calf starter contained much higher concentrations of NFC, as expected.

Results

Calves consumed considerable amounts of hay when it was offered as the primary solid feed. Intake of solid feed differed somewhat among treatments, but overall dry matter intake during the trial was not greatly affected by diet. Growth performance was also similar among treatments. Average daily gain was not significantly different among calves fed hay-only diets compared with those fed diets containing calf starter.

Behavioral measurements indicated that calves fed hay diets spent more time chewing and ruminating, behaviors typically associated with forage consumption. In addition, some indicators of rumen fermentation differed among diets. Calves fed hay had fermentation patterns more typical of forage digestion, with increased acetate production. Calves consuming starter diets produced greater amounts of propionate, consistent with fermentation of starch and other non-fiber carbohydrates.

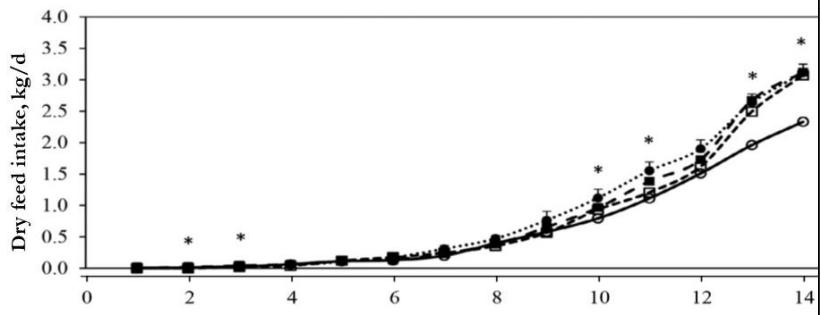

Figure 1. Dry feed intake in calves fed MH (○), HH (□), MH+ (●) or HH+ (■).

Some metabolic indicators measured in blood suggested differences in rumen metabolism around weaning. In particular, calves fed high-quality hay showed increased indicators associated with ruminal ketogenesis, which the authors interpreted as evidence of active rumen fermentation.

Importantly, despite differences in rumen fermentation patterns and chewing activity, overall body weight gain and feed intake were not significantly different among treatments during the experimental period.

Interpretation

An important observation regarding feeds offered in the trial was the quality of the two forages fed, but particularly the High Quality Hay. The authors defined the HH as English ryegrass, early cut and dried indoors, resulting in a high proportion of leaves and few stems. The HH was green and aromatic, which may have prompted calves to prefer HH to calf starter.

The high quality of the hay also means that it likely contained significant amounts of digestible nutrients. Compared with typical hay offered to calves on farms, this forage had relatively high crude protein, relatively low lignin, and moderate concentrations of non-fiber carbohydrates. These characteristics would allow substantial rumen fermentation and production of volatile fatty acids, even in the absence of large amounts of grain.

Another factor that may have influenced the results was the feeding of milk during the pre-weaning period. Calves in the study received acidified milk offered ad libitum early in life and continued to receive milk until

12 weeks of age. Milk provides substantial metabolizable energy, which may reduce the importance of solid feed as an energy source during the early stages of the trial.

Therefore, calves in the study may not have relied heavily on solid feed to support growth during much of the experimental period. Under these conditions, differences in the composition of solid feeds may have had relatively small effects on growth rate.

Finally, it is important to recognize that the fermentation patterns produced by forage and concentrate diets are different. Concentrates rich in starch and sugars tend to produce greater amounts of propionate and butyrate, which have been shown in many studies to stimulate development of rumen papillae. Forage fermentation produces larger amounts of acetate and generally lower concentrations of these acids.

For these reasons, the traditional recommendation to provide calf starter rich in non-fiber carbohydrates remains well supported by decades of research on rumen development. The results of Poier et al. (2022) and Terler et al. (2022) suggest that very high-quality forage can support acceptable intake and growth under the conditions of their experiment. However, these results should not necessarily be interpreted to mean that forage-only diets are optimal for rumen development or post-weaning performance under typical farm conditions.

Instead, the results may highlight the importance of forage quality and the role of physically effective fiber in supporting rumen function and calf behavior.

References

Poier, G., G. Gerler, F. Klevenhusen, S. Sharma, and Q. Zebeli. 2022. Replacing concentrates with a high-quality hay in the starter feed of dairy calves: II. Effects on the development of chewing and gut fermentation, and selected systemic health variables. J. Dairy Sci. 105:3113-3128. https://doi.org/10.3168/jds.2021-21346.

Terler, G., G. Poier, F. Klevenhusen, and Q. Zebeli. 2022. Replacing concentrates with a high-quality hay in the starter feed in dairy calves: I. Effects on nutrient intake, growth performance, and blood metabolic profile. J. Dairy Sci. 105:2326–2342. https://doi.org/10.3168/jds.2021-21078.

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