March 14, 2005
Volume 77, Number 11

REPRINT

Feedstuffs
THE WEEKLY NEWSPAPER FOR AGRIBUSINESS

Role of forage in calf's rumen development may be problematic

By AL KERTZ

Rumen development in calves was addressed from a historical perspective by Warner (1991), and key conclusions were:

• Dry feed consumption initiates rumen development, which is well under way towards adult function by two months of age.

• Concentrates are at least equally to if not more stimulatory for papillae growth than hay.

• Fermentation end products stimulate papillary proliferation in the order of butyrate > propionate > acetate.

• The "scratch factor" of roughage has no impact *per se* on papillary development.

• Hay consumption results in larger forestomachs but at the expense of rapid growth.

• Large forestomach capacity appears not to stimulate forage intake, and in fact, rumens will shrink to accommodate to the feed the animal is consuming. The rumen does not act like a vacuum cleaner.

• A consistent fermentation is needed to maintain the integrity of rumen papillae.

Recent research

With those points in mind, a recent report (Coverdale et al., 2004) evaluated forage fed in a starter program. Holstein bull calves (n = 60) were used in trial 1 after purchasing through sale barns at approximately two to five days of age with an average bodyweight of 97 ± 11 lb. Calves were randomly assigned to one of four treatment groups, provided a dose of a colostrum supplement on day of arrival and were housed in individual hutches with wood shavings for bedding. Water was also provided free choice.

During the trial, eight calves died and two more removed "due to failure to consume adequate amounts of starter." Death losses were not related to treatment.

Treatments were a commercial coarse starter; a ground starter with grain processed with a hammermill and intact pellets; coarse starter with 7.5% bromegrass hay (15.6% crude protein [CP] and 37.6% acid detergent fiber [ADF]) of consistent particle size (H1), and coarse starter with 15% grass hay of consistent particle size (H2).

Diets were formulated to be isocaloric and isonitrogenous, although CP values were 22.8, 22.6, 23.5 and 21.7%, respectively, on a dry matter (DM) basis.

Hay was added along with the pellet portion of diets H1 and H2. Hay was chopped and sorted by particle size using the Penn State Forage Separator (Lammers et al., 1996). Hay particles were approximately 8-19 mm in length.

Form of each diet was: rolled corn, whole oats and intact pellets (coarse); rolled corn and whole oats processed with a hammermill and intact pellets (ground); rolled corn, whole oats, modified intact pellets and 7.5% hay (H1), and rolled corn, whole oats, modified intact pellets, and 15% hay (H2).

A 20% CP-20% fat milk replacer was fed at 10% of initial bodyweight daily by bottle and held constant at this level across treatments until wean-

TABLES

1. Performance of calves in trial 1

Starter	Coarse	Ground	H1	H2
ADG, lb.				
Preweaning	0.37	0.37	0.40	0.40
Postweaning	2.00	1.63	2.69	2.25
Gain:feed				
Preweaning	0.17	0.18	0.20	0.20
Postweaning	0.52	0.42	0.66	0.58
DMI, lb.	2.11	2.18	2.29	2.20

2. Performance of calves in trial 2

Starter	Coarse	Ground	H1	H2
Starter intake, lb.				
Preweaning	0.57	0.59	0.66	0.64
Postweaning	3.50	3.46	4.16	3.90
ADG, lb.				
Preweaning	0.70	0.84	0.77	0.77
Postweaning	1.72	1.59	1.87	1.81
Gain:feed				
Preweaning	0.59	0.68	0.62	0.65
Postweaning	0.50	0.50	0.51	0.57

3. Roughage levels and gut fill

Roughage, %	4	16	25	31	61
ADG, lb.	1.30	1.32	1.03	0.92	0.70
Live bodyweight, lb.	169	171	152	139	130
% of live bodyweight					
Reticulorumen	10.0	10.8	13.6	15.3	18.4
Alimentary tract	14.7	15.4	18.6	20.4	23.3

■ *Dr. Al Kertz is an independent dairy nutrition consultant based out of St. Louis, Mo. His area of specialty is dairy calf and heifer nutrition and management. To expedite answers to questions concerning this article, please direct inquiries to* Feedstuffs, *Bottom Line of Nutrition, 12400 Whitewater Dr., Suite 160, Minnetonka, Minn. 55343.*

ing. Calves were not provided more starter until more than 80% of them consumed all starter offered. Calves were offered only 0.55 lb. daily on days 2-24 of the trial, 0.77 lb. daily on days 25-47 and 1.0 lb. daily on days 48-50. Weaning was instituted when all calves were consuming 1.0 lb. on day 52 of the trial. Data were collected for another 12 days postweaning.

A second trial was done using 48 Holstein, three Jersey, two Ayrshire and three Brown Swiss calves from a community college herd. Different breeds resulted in a lower initial bodyweight with more variability (86 ± 11 lb.) than in trial 1.

Protocol and diets were similar to trial 1 except for a 22% CP-20% fat milk replacer; weaning was instituted when calves consumed 1.5% of initial bodyweight for three consecutive days, and all diets were offered *ad libitum* from day 1 on.

Results

In trial 1 (Table 1), there were no differences among treatments in average daily gain (ADG) preweaning. Postweaning, calves fed coarse starter gained more ($P < 0.05$) than calves fed ground starter but less ($P < 0.05$) than H1 and H2 calves. Higher ADG for H1 and H2 could be due at least partially to gut fill from forage.

Since milk replacer and starter intakes were both limit fed, there were no dry matter intake (DMI) differences across treatments. Limit feeding also resulted in very low ADG preweaning and the consequent jump in ADG postweaning. The ratio of bodyweight gain to DM consumed (gain:feed) was not different preweaning but followed the same pattern as ADG postweaning.

Total volatile fatty acids (VFAs) increased ($P < 0.05$) and were higher ($P < 0.05$) for ground starter versus coarse starter and tended ($P < 0.10$) to be higher for calves fed H1 and H2. A similar pattern existed for propionate concentration while acetate and butyrate concentrations were greater ($P < 0.01$) for calves fed ground versus coarse starter. Plasma beta hydroxybutyrate concentrations did not differ by treatment in any part of trial 1.

In trial 2 (Table 2), there were no differences ($P < 0.05$) in starter intake, ADG or gain:feed. Total VFAs were not measured in this trial. Plasma beta hydroxybutyrate concentrations did not differ among treatments.

Age at weaning was 32.5, 30.7, 31.6 and 30.9 days for treatments coarse, ground, H1 and H2, respectively. This reflects no difference in starter intake among treatments. It also contrasts with trial 1 in which starter intake was limit fed and weaning delayed until day 52 of that trial.

So, what does all of this mean in reference to Warner's conclusions? Any experiment has some limitations that affect the resulting conclusions. In the trials of Coverdale et al. (2004), some of those limitations were no height measurements, no rumen papillae measurements and no accounting of gut fill.

Without height measurements, it is not possible to determine whether daily gains were also reflected in corresponding height increases or whether daily gain was confounded by gut fill. Also, without rumen papillae measurements, a good measurement of rumen development is lacking. Granted, VFA measurements may be able to contribute indirectly to a measure of rumen development, but the direct measure was still lacking.

In a classic British study (1966), the effect of roughage level in starter diets was measured in calves weaned at five weeks of age and slaughtered at 12 weeks of age.

After three weeks of age, calves were fed hay and water *ad libitum* along with a starter fed at five different amounts, resulting in different proportions of roughage in the total diet. This resulted in the roughage levels shown in Table 3.

As roughage level increased from 4 to 16%, there was a slow increase in gut fill but a considerably greater increase in gut fill above 16%. The problem is that at any level of roughage in a young calf's diet, it is bulky, has a slow rate of digestion/fermentation and has a low extent of digestion/fermentation.

All of these factors contribute to gut fill and potentially feed back negatively on intake. The fermentation of hay is also not conducive to the VFA profile most supportive to rumen papillae development. Last, those parameters influencing gut fill and rumen fermentation are not easy to measure. They also are likely to be under the threshold of differentiating by using performance parameters.

The Bottom Line

Use of forage in young calf diets is problematic due to the negative impact on rumen development, intake and daily gain. If calf starters are properly formulated, manufactured and fed, forage is unnecessary for young calves.

REFERENCES

Coverdale, J.A., H.D. Tyler, J.D. Quigley III and J.A. Brumm. 2004. Effect of various levels of forage and form of diet on rumen development and growth in calves. J. Dairy Sci. 87:2554-2562.

Lammers, B.P., D.R. Buckmasters and A.J. Heinrichs. 1996. A simple method for the analysis of particle sizes of forage and total mixed rations. J. Dairy Sci. 79:922-928.

Stobo, I.J.F., J.H.B. Roy and H.J. Gaston. 1966. Rumen development in the calf. 1. The effect of diets containing different proportions of concentrates to hay on rumen development. Br. J. Nutr. 20:171-188.

Warner, R.G. 1991. Nutritional factors affecting the development of a functional ruminant — A historical perspective. Proc. Cornell Nutr. Conf., p. 1-13. ■