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Physical starter form matters in calf growth

Bottom Line

with
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WHILE preparing a calf presentation this past year with the proverbial title of "Recent Advances in Calf ...," it occurred to me that it was difficult to do without relating to some of the historical research.

Here is how I rationalized the approach I took: *What is old some have not heard or applied. What is new may not be well understood without the old.*

More recently, I was struggling with how to deal with a calf starter that was largely in meal form. I recalled research done by John Porter, who was a master's of science graduate student (1973) while I was also a graduate student at Cornell University.

While I was involved in a large project on growth and development of cattle, Porter's project was on calf starter form and fiber level. A very brief synopsis of that was presented at the Cornell Nutrition Conference that fall by Warner et al. (1973).

Now, fast-forward to the 1994 American Dairy Science Assn. (ADSA)/ American Society of Animal Science (ASAS) meetings in Minneapolis, Minn.

During a very lively evening discussion at the Informal Calf Session, I found myself referring to this work and other work that Warner and his graduate students had done with calves.

The following morning, I happened to meet R.G. (Dick) Warner, who promptly said he wanted to treat me to lunch, his rationale being that I had said "nice things" about his research the previous evening.

My rejoinder was that I would have been derelict in not saying those things, especially since I was aware of that work. So, I would not go to lunch with him on that basis, but I would go to lunch so that I could visit with him. It was one of those memorable events and an opportunity for further discussion.

Warner had an infectious energy and was a great teacher with a sense of humor. He was also, by his own acknowledgement, a procrastinator. Therefore, much of his calf research did not get published in journals but invariably found its way into the annual Cornell Nutrition Conference proceedings. His historical perspective (Warner, 1991) is a classic still worth reading.

A few years later, before he died in 2002, just months in front of the Quebec City, Que., annual ADSA/ASAS/Canadian Society of Animal Science meetings, he confided to me that he most regretted not publishing John Porter's master's thesis work.

So, belatedly, in tribute to Warner and in the interest of the science and its application, Porter (University of New Hampshire extension professor and dairy specialist emeritus and owner of Farm Planning Services LLC) dusted off his thesis work, and the data now have been published (Porter et al., 2007).

Calf starter

Forty-eight Holstein heifer calves were purchased over a two- to three-week period from a local auction, were assumed to be about three days old and were placed in slatted metal or wooden-bottom elevated crates with no bedding. Thirty-two of those calves were fed twice-daily milk replacers containing mostly 24% protein/20% fat, but some calves on the second replicate, when having severe scouring, were fed a 22/8 milk replacer — all on the schedule shown in Table 1.

Calf starter was fed free choice beginning on the second or third day starting at about 0.5 lb. daily and increasing as necessary. Water was available free choice.

When calves consumed 1.5 lb. of starter daily for four to five days, they were abruptly weaned from milk replacer and given only starter and water free choice.

Records were kept on the first day observed ruminating. During the last week, calves were checked every two hours during the day for signs of rumination with a simple plus or minus designation.

One calf from each treatment was slaughtered at the end of the study, and rumen pH, volatile fatty acid (VFA) and papillae measurements were recorded.

Additionally, 16 bull calves were fed the same diets, and digestion measurements were taken between the seventh and eighth week, when intake level was held constant.

The objective was to examine the effect of fiber level and physical form of the starter on the growth and development of calves on a no-forage diet.

Composition of calf starters (Table 2) varied in order to create fiber level differences.

In order to create a physical form difference, half of each fiber level feed mixture was ground and pelleted, and the other half was left in coarse mash form, providing the basis for a 2 x 2 trial. Particle size distribution and proximate analyses are shown in Table 3.

Low-fiber diets had about 80 and 65% of the neutral detergent fiber (NDF) and acid detergent fiber (ADF) content of high-fiber diets, respectively, while protein was lowest in high-fiber mash, followed by low-fiber pellet.

Particle size distribution was greater for mash than for pellet diets, as would be expected. This was partly attributed to sampling difficulty. High-fiber diets had greater pellet hardness than low-fiber diets, and low-fiber diets had more fines.

What is now considered low milk replacer intake (Table 4) was due to lower feeding levels and abrupt weaning at an average of four weeks on trial.

While there were numerically greater gains and starter intake on high-fiber versus low-fiber diets, these differences were greater for coarse mash versus pellet and significant ($P < 0.05$) for both daily gain and starter intake during the last four weeks after weaning and overall for the eight-week trial.

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Because of the early weaning, the effect of starter was maximized when the starter was the only feed available along with water, and remember that there was no bedding available for calves to consume. (In e-mail correspondence, Porter also noted that calves drank more water associated with the increased coarse mash starter intake).

There were no differences in medications, body temperature and observations of semi-loose and semi-solid feces. However, by diet, loose feces was the lowest ($P < 0.05$) for high-fiber coarse mash, followed by low-fiber pellet, high-fiber pellet and low-fiber coarse mash, respectively (1.78, 4.25, 5.88 and 6.57 incidences).

Rumen function was measured by week first observed ruminating, and percent of time ruminating was greatest ($P < 0.01$) for coarse mash versus pellet (Table 5). Feed efficiency was slightly better numerically (i.e., less starter per pound of gain) for high fiber versus low fiber and for coarse mash versus pellet.

Data for the single calf slaughtered per diet also showed a similar pattern among diets. A higher ratio of acetic/propionic VFAs in the rumen was associated with more normal rumen fermentation and was noted for high versus low fiber and for coarse mash versus pellet diets. Even more telling is that both the high fiber versus low fiber and coarse mash versus pellet comparisons were associated with higher butyric VFA concentration in the rumen — the fatty acid most associated with rumen papillae development and rumen function in young calves.

Apparent digestibilities from the bull calves during weeks 7-8 were greater for dry matter and total digestible nutrients (TDN; $P < 0.01$) when comparing low versus high fiber and for coarse mash versus pellet; apparent digestibilities for ADF and NDF ($P < 0.01$) were also higher for coarse mash versus pellet (Table 6).

My thanks go to Porter, who provided a copy of his thesis to me in 1973 — which became the basis for the 13 calf digestion trials I did while with Ralston Purina/Purina Mills — and who reviewed this article prior to its publication.

The Bottom Line

Coarser mash calf starters facilitated earlier rumen function and greater starter intake with greater daily gain and digestibilities after weaning than pelleted diets. These differences were generally greater than for high-fiber versus low-fiber diets.

References

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1. Milk replacer schedule

Days of age	Milk replacer, lb.	Warm water, lb.
1-5	0.30	3.0
6-8	0.40	3.5
9-11	0.50	4.0
12 to weaning	0.50	5.0

2. Composition of calf starters

Ingredients, %	Low fiber	High fiber
Corn and cob meal	—	20.0
Cracked corn	33.8	—
Crushed oats	35.0	25.0
Beet pulp	—	16.0
Brewers grains	—	10.0
Soybean meal (50%)	20.7	18.0
Molasses	7.0	7.0
Minerals	4.0	4.0

3. Particle size distribution (%) and proximate analyses

Particle	--------Low fiber--------		--------High fiber--------	
size mash	Pellet	Coarse mash	Pellet	Coarse
> 2,380 µ	3.7	73.4	8.2	51.8
1,190-2,379 µ	12.6	17.1	26.2	30.9
595-1,189 µ	27.6	5.6	27.4	11.2
297-594 µ	28.6	2.1	21.3	3.6
149-296 µ	17.2	1.0	11.5	1.4
< 149 µ	10.3	0.8	5.4	1.1
Weighted mean (µm)	741.6	2,122.9	1,036.2	1,905.8
Protein, % as-fed	20.4	21.9	21.9	18.1
NDF, % as-fed	18.1	15.1	24.1	25.5
ADF, % as-fed	8.7	7.0	12.8	12.6

4. Results

	Low fiber	High fiber	Pellet	Coarse mash
Number of calves	15	17	16	16
Initial bodyweight, lb.	85.9	87.3	87.9	85.3
Daily gain, lb.				
Weeks 0-4	0.33	0.35	0.31	0.40
Weeks 5-8	1.15	1.37	1.12[a]	1.41[b]
Weeks 0-8	0.75	0.86	0.70[a]	0.90[b]
Milk replacer intake, lb.	21.4	21.5	22.1	20.8
Weaning age, days	27.1	28.1	28.1	27.1
Starter intake, lb.				
Weeks 0-4	19.3	22.5	19.2	22.5
Weeks 5-8	92.3	105.4	85.6[a]	112.1[b]
Weeks 0-8	111.1	127.9	104.8[a]	134.2[b]

[a,b]$P < 0.05$.

5. Rumen function parameters

	Low fiber	High fiber	Pellet	Coarse mash
Week of first ruminating	5.1	4.6	6.0[a]	3.7[b]
% of time ruminating	15.0	14.8	8.7[a]	21.0[b]
Number of calves bloating	2	2	3	1
Starter per pound of gain, 5-8 weeks	2.95	2.73	2.89	2.82
One calf per diet				
Rumen pH	4.95	5.50	5.03	5.43
Papillae length, cm	2.9	3.5	2.9	3.5
% muscle/mucosa	41.0	47.6	35.8	52.8
Acetic/propionic	1.28	1.38	1.30	1.35
Butyric acid, molar %	11.9	13.6	12.2	13.2

[a,b]$P < 0.01$.

6. Dietary component apparent digestibilities, %

	Low fiber	High fiber	Pellet	Coarse mash
Dry matter	76.5[a]	71.1[b]	71.3[a]	76.3[b]
TDN	74.5[a]	69.2[b]	69.5[a]	74.2[b]
ADF	33.8	38.3	28.8[a]	43.2[b]
NDF	46.1	45.4	39.7[a]	51.9[b]

[a,b]$P < 0.01$.