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Feeding colostrum beyond first day may have growth benefits

By AL KERTZ

Most people recognize the value of feeding colostrum to achieve antibody absorption and protection for newborn calves. The practice of feeding colostrum or transition milk beyond one day through three days of life seems to have largely disappeared. Recently, a series of papers by Blum and associates at the University of Berne in Switzerland has addressed the non-antibody components in colostrum/transition milk and their role in calf growth and metabolism. Calves in these studies were largely newborn males from dairy or dairy cross breeds.

First study

In the first study (Kuhne et al., 2000), during the first three days of life, calves were fed twice daily on one of four treatments: high (HCol) or low (LCol) levels of colostrum and high (HMR) or low (LMR) levels of milk replacer. The same volume of liquid fed was maintained for all treatments. Starting on day 4 and up to day 7, all calves were fed whole milk twice daily. Colostrum was pooled by milking for each of the first six milkings so that calves received colostrum/transition milk appropriate for their age (i.e., on day 2, calves received milkings 3 and 4). The milk replacer contained 22% protein and 20% fat. No starter was fed, and water was fed from day 4 forward. Selected results are shown in Table 1.

Basal was first blood sample at an average of 3.0, 3.25, 3.75 and 4.7 hours after birth by treatments, respectively. All values are for blood plasma concentrations. Basal values were similar, as expected. The pattern of bodyweight change is also largely reflected in plasma parameters with some exceptions. Authors acknowledged that the difference in bodyweight gain between milk replacer and colostrum treatments could have been due to the lower energy and protein content of the milk replacer as well as the absence or lower levels of non-nutritional, growth-promoting substances that stimulate development of the gastrointestinal tract and, directly or indirectly, of other organs.

■ *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.*

TABLES

1. Selected results from first study

	Basal	Day 7
Bodyweight, lb.		
HCol	—	7.6
LCol	—	3.9
HMR	—	1.5
LMR	—	-1.5
Total plasma protein, g/L		
HCol	40.6	54.6
LCol	40.2	47.9
HMR	40.6	41.8
LMR	42.7	45.7
Globulins, g/L		
HCol	9.7	20.4
LCol	9.9	15.1
HMR	10.4	11.5
LMR	10.9	12.8
Glucose, mmol/L		
HCol	3.6	5.1
LCol	3.4	5.4
HMR	4.3	4.7
LMR	4.5	4.5
IGF-1, µg/L		
HCol	134.5	121.2
LCol	158.4	97.4
HMR	121.7	49.6
LMR	144.6	58.1

2. Villi parameters from sampling on day 8

Trait/ treatment	-----Group----- Control	CMR	FMR
Duodenum			
Villus circumference, µm	113	74	78
Villus area, sq. µm	503	251	286
Villus height, µm	44	26	28
Crypt depth, µm	25	25	26
Villus height/ crypt depth	1.8	1.1	1.1

Second study

The second study (Rauprich et al., 2000a) logically followed the hypothesis that maximizing intake of first-milk colostrum during the entire first week of life improves the metabolic, endocrine and clinical status, improves gastrointestinal absorptive capacity and enhances growth performance in calves.

The control received colostrum/transition milk from milkings 1 to 6 (first three days of lactation) for the first three days of life and then milk replacer (21% protein and 20% fat) up to day 7. The treatment group received first-colostrum twice daily for the first three days, and then first-colostrum diluted with 25, 50, 75 and 75 parts of milk replacer on days 4, 5, 6 and 7, respectively. Lower protein and fat in the milk replacer resulted in about 40% less energy on a dry matter basis compared to colostrum/transition milk. At the end of seven days, control calves gained 2.2 lb. while treatment calves lost 2.4 lb. bodyweight.

Higher plasma triglyceride concentrations in treatment calves during days 2 and 3 could have been influenced by the higher fat content of colostrum, but it likely reflected better fat absorption and lipid and fatty acid status in neonatal calves based on studies cited by the authors. Greater insulin response in treatment calves at day 7 was probably due to the greater nutrient intake on this treatment during the entire week. Prolactin and growth hormone responses were the opposite. While xylose absorption tests showed no significant differences among treatments, xylose concentration decreased faster in treatment than in control calves. This was accompanied by significantly greater duodenal villus heights and areas. The authors speculated that changes in intestinal absorptive capacity in response to colostrum feeding intensity might take a longer time to become established.

Third study

In the third study (Rauprich et al., 2000b), three formulas were developed to contain similar amounts of nutrients as bovine colostrum during the first three days of lactation. However, only trace amounts of growth factors (such as insulin-like growth factor-1 [IGF-1]) or hormones (such as insulin) were present in the formulas compared to colostrum, as confirmed by assays.

Calves on the control received colostrum from milkings 1 to 6 (first three days of lactation) for the first three days. Calves on the formula treatment received formula 1 on day 1, formula 2 on day 2 and formula 3 on day 3. From days 4 to 7, calves of both groups received the same milk replacer (21% protein and 22% fat). Calves received the same amounts of liquid during the entire week and were drenched by an esophageal tube if they did not drink all that was fed to them.

Loose feces in formula-fed calves indicated mild disturbances of gastrointestinal tract function, which could have been due to reduced absorptive capacities as seen with the xylose absorption tests. The authors speculated that the near absence of bioactive substances and especially of various colostral growth factors might have, in part, impaired the functional development and digestive capacity of the gastrointestinal tract in formula-fed calves. Similar to the last study, formula-fed calves had lower plasma triglycerides despite high dietary fat, which was similar to control-fed calves.

While total protein and immunoglobulin G (IgG) concentrations markedly increased after the first meal in both groups of calves, concentrations did not reach levels as high in formula-fed as in control calves because no colostral IgG was fed. Plasma insulin and glucagon concentrations increased more in formula-fed than control calves, while growth hormone levels were variable and did not differ between groups.

Plasma cortisol concentrations were higher on days 2 and 3 in formula-fed than in control calves. Thus, the trace amounts of bioactive substances in the formulas appeared to impair intestinal absorptive capacity, protein and fat metabolism and exert effects on endocrine systems in neonatal calves.

Fourth study

In the most recent and fourth study (Blatter et al., 2001), the effects of colostrum were studied on intestinal morphology and proliferation and digestive enzyme activities in neonatal calves. Control calves were fed first colostrum milking for the first three days, followed by dilution with milk replacer (21% protein and 22% fat) at 3:1, 1:1, 1:3 and 1:3 for the following four days. The next treatment (CMR) fed colostrum/transition milk the first three days corresponding to that provided by the cow on those days and then only milk replacer for the following four days. The third treatment (FMR) was fed formulas each of the first three days corresponding to the composition of colostrum in CMR and then only milk replacer for the following four days. Villi parameters from sampling on day 8 are shown in Table 2.

Of the gastrointestinal tract sections sampled, only duodenum sections showed differences. With the exception of villus crypt depth, calves on control-fed colostrum the first three days had greater ($P < 0.01$ or 0.001) villus development parameters, as indicated in Table 2. There were no differences between CMR and FMR treatments.

There were some significant differences in pancreatic enzyme activities for control compared to CMR and FMR but no differences between the latter two groups. Control-fed calves had greater protein, fat and energy intakes during the first three days compared to CMR- and FMR-fed calves. They also had greater levels of growth factors and hormones. These data coupled with the third study (Rauprich et al., 2000b) indicated that these factors would have the greater impact on gastrointestinal tract development rather than differences in intake of the other major nutrients.

At the July 2002 joint animal and dairy science meetings in Quebec City, Que., a symposium paper (Blum, 2002) captured a current, integrated synopsis of this area of research.

The Bottom Line

There is benefit to feeding colostrum or transition milk beyond the first day of a calf's life. Some of this may be attributed to major nutrient differences, but it also appears that other bioactive growth factors play the major role in duodenal villus development and accompanying absorption.

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