Body Weight Gain, Feed Efficiency, and Fecal Scores of Dairy Calves in Response to Galactosyl-Lactose or Antibiotics in Milk Replacers

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ABSTRACT

Holstein bull calves (n = 96) were purchased at approximately 7 d of age and were assigned to receive 400, 450, 500, and 550 g/d of milk replacer solids during wk 1 to 4, respectively. Treatments were nonmedicated milk replacer plus dried whey, medicated milk replacer (138 mg/kg of oxytetracycline and 276 mg/kg of neomycin) plus dried whey, or nonmedicated milk replacer plus whey processed with β-galactosidase to contain 15% galactosyl-lactose. Processed whey was added to provide 1% of dry matter as galactosyl-lactose; an equivalent amount of dried whey was added to the other treatments to provide 6.3% of dry matter daily. Intake of milk replacer and fecal scores were measured daily. No calf starter or hay was fed. Body weights were measured weekly from arrival to 26 d. Serum immunoglobulin G, measured 1 d after arrival, averaged 18.3 g/L. Intake of milk replacer plus additive during the 26-d study was 445 g/d and did not vary with treatment. Body weight and body weight gain were increased by 52 and 72 g/d in response to antibiotics and galactosyl-lactose, respectively. Severity of scours and number of days scouring tended to be reduced when calves were fed milk replacer containing galactosyl-lactose or antibiotics.
(**Key words**: calves, milk replacer, antibiotics, oligosaccharide)

Abbreviation key: **GL** = galactosyl-lactose, **MR** = milk replacer, **MRAB** = MR containing antibiotics, **MRGL** = MR containing GL.

INTRODUCTION

Prior to weaning, replacement dairy calves are susceptible to many pathogens that cause disease. Antibiotics, which are extensively used in milk replacers [**MR**; (7)], have been shown to improve performance and reduce scours in dairy calves (14, 24). More recently, oligosaccharides have been proposed as a means to manipulate the bacterial flora of the intestinal tract of animals, potentially reducing the incidence of disease. These carbohydrates may reduce the adhesion of certain bacterial species to the intestinal epithelium, most notably *Escherichia coli* (K99+) and *Salmonella* sp. (11, 16, 18, 19). Furthermore, oligosaccharides may also increase the growth of beneficial intestinal bacteria, including lactobacilli and bifidobacteria (4, 9, 11). Oligosaccharides containing mannose (16, 17, 20) and fructose (9, 25) have been used in the diets of calves and pigs to improve intestinal health and to reduce the incidence of disease. Conversely, Mathew et al. (12) reported no effect of oligosaccharides on nutrient digestibility or ileal concentrations of VFA and lactate in pigs that were weaned early. Intake was increased when 0.5% of the diet contained oligosaccharide.

Galactosyl-lactose (**GL**) is a trisaccharide (galactose plus lactose) that is produced by enzymatic treatment of whey using β-galactosidase derived from *Aspergillus oryzae* (5). The objectives of this study were to determine the effect of GL or antibiotic addition to MR on the growth and health of dairy calves.

MATERIALS AND METHODS

Holstein bull calves (n = 96), approximately 7 d of age, were purchased in two blocks of 48 from sale barns and dairy farms in Tennessee and transported to the experimental facility. Upon arrival, each calf was unloaded, weighed, and placed in an individual fiberglass hutch bedded with straw. Calves were assigned randomly to treatment upon arrival. Approximately 12 h after arrival, a blood sample was collected from the jugular vein of each calf and allowed to clot. Serum was separated by centrifugation (3000 $\times$ *g* for 15 min at 5°C) and stored (–20°C) until analysis in duplicate for IgG concentration by radial immunodiffusion (VMRD, Inc., Pullman, WA).

Calves were weighed upon arrival and at 7, 14, 21, and 26 d to calculate BW gain and efficiency of feed

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TABLE 1. Chemical composition of experimental milk replacers (MR) and additives.[1]

Item	Control MR	MRAB	GL	Whey
DM, %	97.4	98.3	96.7	98.0
	(% of DM)			
CP	25.2	25.5	12.6	14.4
Fat	20.1	19.8	0.6	0.8
Ca	0.94	1.03	1.80	0.58
P	1.17	1.17	1.36	0.83

[1]MRAB = MR containing antibiotics; GL = galactosyl-lactose.

utilization. All calves were fed 2 L of electrolytes (Resorb®; Pfizer Animal Health, West Chester, PA) for two feedings and a probiotic (*Bifidobacterium bifidum*; Chr. Hansen's, Inc., Milwaukee, WI) for three feedings. Calves were then fed the experimental MR for 26 d in two feedings daily at approximately 0800 and 1600 h. The MR (22% CP and 20% fat, air-dry basis) were commercially prepared (Land O' Lakes, Inc., Ft. Dodge, IA) and contained no antibiotics (control) or contained 138 mg/kg of oxytetracycline and 276 mg/kg (air-dry basis) of neomycin (**MRAB**). Calves were fed 400, 450, 500, and 550 g/d of MR during wk 1 to 4, respectively. Amounts of MR fed were chosen to limit BW gain to approximately 200 g/d to reduce calf variation associated with differences in genetic potential, age, immune status, and other factors. Processed whey containing 15% GL (Snow Brand Milk Products, Ltd., Tokyo, Japan) was added to nonmedicated MR to provide 1% of DM as GL (**MRGL**). A similar amount of unprocessed dried whey was added to the control MR and MRAB to provide equal amounts of DM. Additives (GL and whey) were mixed with MR in each nipple bottle prior to feeding. Morbidity, mortality, number of days scouring, and severity of scouring over the 26-d period were determined. Fecal consistency was estimated daily at the a.m. feeding (10). Use of electrolytes and antibiotics was recorded for each calf. Electrolytes were fed at an additional feeding (approximately 1200 h) when calves were visibly dehydrated or when calves had a fecal score >2. When calves were fed electrolytes, milk replacer continued to be fed. Antibiotics were administered for 3 d when the fecal score was >2 or when rectal temperature was ≥39°C. Analgesics were administered when the rectal temperature was ≥39°C.

Remaining MR at each feeding was weighed back and reported daily. Water was available at all times. No calf starter or hay was fed. Samples of MR, whey, and GL were taken weekly, composited, and analyzed for DM, CP, fat, Ca, and P (2).

TABLE 2. Least squares means[1] of BW gain, scours, intake, and feed efficiency of calves fed milk replacer (MR) containing antibiotics or galactosyl-lactose (GL) for 26 d.

	Treatment[2]				Contrast[3]	
Item	Control MR	MRAB	MRGL	SE	AB	GL
					P	
Calves, no. started	32	32	32	...	...	...
Calves, no. ended	32	32	30	...	...	...
BW						
Initial, kg	39.2	41.1	43.3	0.7	0.08	0.01
Final, kg	44.4	45.7	46.2	0.5	0.07	0.02
Daily gain, g	125	177	197	21	0.07	0.02
Fecal score[4]	2.27	2.07	2.06	0.8	0.07	0.08
Days scouring	19.4	17.3	16.9	0.9	0.12	0.08
DMI, g/d	475	474	475	0.3	NS[5]	NS
MR	445	445	445	0.3	NS	NS
Additive[6]	30	30	30	0.1	NS	NS
BW Gain:DMI, g/kg	282	399	443	47	0.07	0.08
Serum IgG, g/L	17.2	20.2	17.4	2.2	NS	NS

[1]Adjusted for initial BW, except initial BW.

[2]Treatments: control MR = commercial nonmedicated MR plus 1% whey, MRAB = commercial medicated MR plus 1% whey, and MRGL = commercial nonmedicated MR plus 1% GL.

[3]Contrasts: AB = control MR versus MRAB; GL = control MR versus MRGL.

[4]Mean fecal score: 1 = normal fecal consistency to 4 = severe scours.

[5]$P > 0.10$.

[6]Additives were dried whey (control MR and MRAB) or GL (MRGL) added at 6.3% of DM.

Data were analyzed as a randomized complete block experimental design (6) using SAS (21). However, neither blocking effect (shipment of calves) nor the interaction of block and treatment was significant; therefore, data were reanalyzed as a completely randomized experimental design by ANOVA. Calf BW at arrival was included in each model as a covariant. Significance was declared at $P < 0.05$ unless otherwise noted.

RESULTS AND DISCUSSION

Calves that died within 7 d of arrival at the experimental facility because of failure of passive transfer of immunity, exposure to pathogens during transport, or both, were replaced. Two calves fed MRGL died at 18 and 24 d, respectively, and were not replaced.

The chemical composition of MR (Table 1) consistently met or exceeded label guarantees (22% CP and 20% fat, air-dry basis) and met or exceeded NRC (15) recommendations for CP and fat. Composition of the GL product, according to the manufacturer, was 38% lactose, 15.0% GL, 10.6% CP, 3.5% fat, and 11.9% ash (air-dry basis).

Mean serum IgG at 24 h after arrival was 18.3 g/L (SE = 1.3) and ranged from 2.0 to 52.2 g/L (Table 2). Failure of passive transfer, defined as ≤10 g/L of serum IgG concentration, was measured in 33% of the calves purchased.

Intake of MR was similar among treatments (Table 2); MR was refused only when calves exhibited signs of disease. Addition of whey or GL did not affect consumption of MR; however, addition of processed whey containing GL required extensive mixing to solubilize the material. Occasionally, clumps of powder were observed in nipple bottles of calves fed MRGL, indicating incomplete mixing. However, clumps were small enough to pass through the nipple and be consumed by calves.

Calves scoured (fecal score ≥2) for a mean of 17.8 d (SE = 0.5) or approximately 68% of the experiment. However, most scours were minor (fecal score = 2) during the study and were probably related to the feeding program (no calf starter or hay offered).

Body weight at 26 d and BW gain were improved by inclusion of GL or tended ($P < 0.10$) to be improved by inclusion of antibiotics in the MR. Mean BW gains were 42 and 58% greater when calves were fed MRAB and MRGL, respectively (Table 2). Mean BW gain for the 26-d period was 166 g/d (SE = 12), which reflected the limited MR consumption in this study. Efficiency of feed utilization for BW gain tended ($P < 0.10$) to be improved when antibiotics or GL was fed (Table 2). Improved efficiency of feed utilization was consistent with reduced incidence of scours and improved BW gain when the consumption of MR is limited.

Antibiotics in MR have been shown to reduce the incidence of scours and to improve BW gain in calves (13, 24). Our study confirms those findings. Results from the use of probiotics (bacterial cultures, oligosaccharides, and yeast) in MR generally have been equivocal. Responses to the addition of these products to MR or calf starter generally have been significant when calves were exposed to stresses (1, 3, 22, 23) and not significant when calves were not stressed (8, 14). Abe et al. (1) reported that the addition of bifidobacteria to the diets of calves increased BW gain and reduced fecal scores, particularly when antibiotics were not fed to calves prior to weaning. In the current study, limited MR and a lack of calf starter restricted BW gain and reduced variability of BW gain and feed efficiency. Thus, reduction in the number of days scouring and fecal score were more completely reflected in changes in BW and feed efficiency. Further research is required to determine whether GL influences health, changes in BW, and feed efficiency when calves are fed calf starter for ad libitum consumption and when amounts of MR are more typical of those used in the industry.

CONCLUSIONS

The MRGL and MRAB reduced the severity of scours and increased BW gain and efficiency of feed utilization in this study. Changes in growth and feed efficiency appeared to be related to improvements in intestinal health and reduction of severity and duration of scours. Further research is required to determine whether GL is effective under typical management conditions, including greater MR consumption and ad libitum access to calf starter.

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