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Effects of Milk Feeding Strategies on Short- and Long-term Productivity of Holstein Cows

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Abstract

The objectives of this study were to determine the impacts of feeding preweaning heifers with a high protein milk replacer (MR) or a raw or pasteurized non-saleable milk (NSM) on preweaning and first lactation performance. Holstein heifers (n = 154) were blocked by birth date and weight (BW) and within block randomly assigned to 1 of 3 treatments: 1) MR (4% protein and 2.6% fat, liquid basis); 2) pasteurized NSM (PNSM, 3.6% protein and 4.1% fat, liquid basis); or 3) raw NSM (RNSM, 3.6% protein and 4.1% fat, liquid basis). Heifers in RNSM were fed raw colostrum whereas heifers in MR and PNSM were fed pasteurized colostrum. Heifers were fed milk treatments 3 times per day. Low BW heifers (< 80 lb) were fed 3 pints/feeding until the target BW was achieved (then 4 pints/feeding), whereas high BW heifers (≥ 80 lb) were fed 4 pints/feeding since birth. After weaning (≥ 42 d of age and consuming at least 2 lb grain mix for 3 consecutive days), all heifers were uniformly managed. Heifers fed MR instead of NSM ate less grain (0.76 vs. 0.95 lb/d, P = 0.01). Low BW heifers fed RNSM had lesser average daily gain than high BW heifers fed RNSM (P = 0.01) but daily gain did not differ among heifers fed PNSM, perhaps because low BW heifers consumed more grain than high BW heifers on this treatment (P = 0.01). The 305-day mature equivalent (ME) milk yield was lower for low BW heifers compared with high BW heifers, but only when fed RNSM (28,785 vs. 32,542 lb ME milk, P = 0.04). Similarly, ME fat yield was reduced when RNSM was fed to low-BW heifers (1,094 vs. 1,244 lb ME fat, P = 0.05). The type and quantity of milk fed did not impact reproductive efficiency (P > 0.10). Feeding RNSM may impair the first lactation performance of low BW heifers, whereas it did not appear to affect high BW heifers.

Keywords

Heifers, milk replacer, pasteurization, life-long performance

Effects of Milk Feeding Strategies on Short- and Long-term Productivity of Holstein Cows

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Summary

The objectives of this study were to determine the impacts of feeding preweaning heifers with a high protein milk replacer (MR) or a raw or pasteurized non-saleable milk (NSM) on preweaning and first lactation performance. Holstein heifers (n = 154) were blocked by birth date and weight (BW) and within block randomly assigned to 1 of 3 treatments: 1) MR (4% protein and 2.6% fat, liquid basis); 2) pasteurized NSM (PNSM, 3.6% protein and 4.1% fat, liquid basis); or 3) raw NSM (RNSM, 3.6% protein and 4.1% fat, liquid basis). Heifers in RNSM were fed raw colostrum whereas heifers in MR and PNSM were fed pasteurized colostrum. Heifers were fed milk treatments 3 times per day. Low BW heifers (< 80 lb) were fed 3 pints/feeding until the target BW was achieved (then 4 pints/feeding), whereas high BW heifers (≥ 80 lb) were fed 4 pints/feeding since birth. After weaning (≥ 42 d of age and consuming at least 2 lb grain mix for 3 consecutive days), all heifers were uniformly managed. Heifers fed MR instead of NSM ate less grain (0.76 vs. 0.95 lb/d, $P = 0.01$). Low BW heifers fed RNSM had lesser average daily gain than high BW heifers fed RNSM ($P = 0.01$) but daily gain did not differ among heifers fed PNSM, perhaps because low BW heifers consumed more grain than high BW heifers on this treatment ($P = 0.01$). The 305-day mature equivalent (ME) milk yield was lower for low BW heifers compared with high BW heifers, but only when fed RNSM (28,785 vs. 32,542 lb ME milk, $P = 0.04$). Similarly, ME fat yield was reduced when RNSM was fed to low-BW heifers (1,094 vs. 1,244 lb ME fat, $P = 0.05$). The type and quantity of milk fed did not impact reproductive efficiency ($P > 0.10$). Feeding RNSM may impair the first lactation performance of low BW heifers, whereas it did not appear to affect high BW heifers.

Introduction

According to the U.S. Department of Agriculture, small- and medium-sized dairies relay heavily on milk for calf feeding. Among the dairies feeding milk, more than 50% feed unpasteurized saleable or NSM, whereas only 5% of the small but 43.8% of the large dairies feed pasteurized milk.

Smaller-scale pasteurization systems are now available and are becoming more widely used by medium and small dairies. Research conducted in the last decades has proven the efficacy of on-farm pasteurization for reducing microbial load in colostrum and milk. Furthermore, the benefits of enhanced preweaning growth on milk yield in the subsequent lactation has been concluded in two recent meta-analyses. One of those studies also concluded that preweaning management was the major factor contributing to the variation in milk production at first lactation.

Studies have reported that "accelerated" (28% CP and 20% fat) compared with a "traditional" (20% fat, 20% protein) milk replacer (MR) feeding programs increase preweaning growth rates. However, when an accelerated MR feeding program is compared with milk feeding, even at comparable concentration of nutrients, calves fed milk often outperform those fed MR. The current study hypothesizes that feeding a PNSM relative to feeding RNSM or a high-protein MR would not only benefit the health and growth of heifers during the preweaning period but would extend into first lactation performance.

Experimental Procedures

Holstein heifers (n = 154) born at the Kansas State University Dairy Teaching and Research Center, Manhattan, KS, with BW > 60 lb and calving ease score < 3 were enrolled in the study. Heifers were blocked by birth date and BW (< or ≥ 80 lb) and were randomly assigned within block to 1 of 3 treatments: (1) MR, (2) PNSM, or (3) RNSM. Heifers in the RNSM group were fed raw colostrum whereas heifers in MR and PNSM groups were fed pasteurized colostrum. Warm colostrum (> 50 g/L of immunoglobulin G, 1.5 gallons total) was provided at ≤ 2, 6, and 12 hours after birth. All milk treatments were fed at 99°F 3 times per day. The NSM was obtained from the dairy, and was sampled weekly before (4.12 ± 0.37%, 3.59 ± 0.28%, and 1,662 ± 771 cells/µL for fat, true protein, and SCC content, respectively) and after pasteurization (4.14 ± 0.35%, 3.61 ± 0.29%, and 1,575 ± 704 cells/µL for fat, protein, and SCC content, respectively). The MR (Mother's Pride, Hubbard Feeds, Mankato, MN; 28% protein and 18% fat on a DM basis) was mixed according to the manufacturer's recommendations. The reconstituted milk replacer (14.2% total solids) provided the same metabolizable energy concentration as milk; therefore, treatments were fed on an equal-volume basis. Low BW heifers (< 80 lb) were fed 3 pints at each feeding until they reached 80 lb (thereafter fed 4 pints/feeding), whereas high BW heifers (≥ 80 lb) were fed 4 pints at each feeding. Body weight and shoulder and hip heights were recorded at birth and then once a week until heifers were 8 weeks old and every 4 weeks thereafter, until heifers were 24 weeks old.

After weaning (≥ 42 d of age and consuming at least 2 lb grain mix for 3 consecutive days), all heifers were uniformly managed according standard procedures. Weaned heifers were moved to sod pens, grouped according to BW, and fed diets formulated to supply their nutrient requirements. Heifers were rotated among sod pens according to growth and reproductive status. Two months before the expected calving date, heifers were moved to a maternity pen bedded with straw where they were frequently monitored for signs of calving. Upon calving, heifers were moved to free-stall barns equipped with sprinklers and fans, and fed a totally mixed ration (TMR) formulated to meet nutrient requirements for lactating dairy cows. Cows were milked 3 times daily. Milk yield and composition data used for 305-day ME yield data were derived from monthly testing by the Dairy Herd Improvement Association. For ME milk, protein, and fat yield data, the predicted transmitted ability of the corresponding variable was used as covariate to account for genetic differences between animals. Cull dates and reasons for culling were also obtained from the PC-DART.

Results

The type of milk fed (MR or NSM) did not affect average daily gain (ADG) or weaning age (Table 1), but heifers fed MR instead of NSM ate less grain mix (0.76 vs. 0.95 lb/d). The effect of pasteurization was impacted by BW group. Low BW heifers fed RNSM had lower ADG than high BW heifers fed the same type of milk (1.33 vs. 1.76 lb/d). However, no difference in ADG was observed between low BW and high BW heifers fed PNSM (1.54 vs. 1.44 lb/d for low and high-BW heifers, respectively). Similar effects were observed for ADG measured from birth to 24 weeks of age (Table 1). When fed PNSM, low BW heifers consumed more grain than high BW heifers, but not when they were fed RNSM; consequently, the odds of low BW heifers fed PNSM to be weaned at 6 weeks of age were ~3 times greater compared with low BW heifers fed RNSM.

Neither the type nor the amount of milk fed (nor their interaction) impacted shoulder and hip heights during the first 24 weeks of age (Table 1). The number of AI required to attain first pregnancy was not affected by treatments, and all heifers had their first calf at a similar age (22.6 ± 0.3 months).

First lactation 305-day ME milk yield was substantially diminished in low BW heifers fed RNSM compared with high BW heifers fed RNSM (28,785 vs. 32,542 lb, Table 1). Similarly, ME fat was also compromised when RNSM was fed to low BW heifers (1,094 vs. 1,244 lb for low and high BW heifers, respectively). In contrast, when fed PNSM, low and high BW heifers produced similar amounts of ME milk and fat (Table 1). The type and quantity of milk fed did not impact reproductive efficiency, as no difference was observed in days open. Finally, survival in the herd did not differ between treatments (Figure 1).

Discussion

Our results indicate that feeding a high protein MR, characteristic of an accelerated feeding program, compared with feeding NSM, regardless of pasteurization, did not have any benefit on preweaning and first lactation performance.

In this study, low BW heifers were fed lesser amounts of milk (9 pints/d) before they reached 80 lb to attempt to prevent potential digestive problems associated with excess intake relative to body size. This population (21% of the total enrolled heifers), uniquely benefited from pasteurization of colostrum/NSM. Low BW heifers fed PNSM ate more grain than their weight-matched peers fed RNSM (+0.29 lb/d) and more than high BW heifers fed PNSM (+0.28 lb/d), improving their opportunity for early weaning. Furthermore, the greater intake of solid feed may have contributed to growth rates similar to those of high BW heifers fed PNSM, which were not matched by low BW heifers fed RNSM.

Importantly, the feeding of raw colostrum and RNSM impaired not only the preweaning performance of these low BW heifers, but also had detrimental effects on their first lactation. Heifers that were fed PNSM, no matter their BW at birth, produced similar amounts of ME milk and fat, whereas low BW heifers fed RNSM produced 3,757 and 150 lb less ME milk and fat, respectively, compared with high BW heifers fed RNSM.

Conclusions

Feeding raw NSM may impair the long-term productivity of low BW heifers whereas the same effect appeared not to affect high BW heifers. Pasteurized NSM and an accelerated MR supported similar growth and first-lactation performance across heifers of low and high BW.

Table 1. Performance of heifers fed milk replacer (MR) or pasteurized or raw non-saleable milk (PNSM and RNSM, respectively) from birth to weaning (≥ 6 weeks)

	Milk replacer		Pasteurized NSM		Raw NSM			*P*-value[2]				
	LBW[1]	HBW	LBW	HBW	LBW	HBW	SEM	TM	Past	BW	TM × BW	Past × BW
From birth to 42 d of age												
BW, lb	71.2	87.6	69.8	88.5	72.7	88.2	1.6	0.77	0.49	< 0.01	0.80	0.34
Average daily gain, lb/d	1.58	1.60	1.54	1.44	1.33	1.76	0.10	0.47	0.60	0.12	0.33	0.01
Grain intake, lb/d	0.78	0.74	1.12	0.84	0.83	0.99	0.08	0.01	0.43	0.38	0.84	0.01
Weaning by 42 d, HR[3]	1.65	0.98	3.15	1.34	1.00	1.34	-	0.25	0.01	0.04	0.77	0.01
From birth to 24 weeks of age												
ADG, lb/d	1.94	1.90	1.95	1.87	1.77	2.02	0.07	0.81	0.84	0.52	0.29	0.03
Shoulder height, inches	34.2	35.4	34.2	35.3	34.3	35.5	0.2	0.97	0.53	< 0.01	0.78	0.89
Hip height, inches	36.0	37.5	35.9	37.2	36.3	37.4	0.2	0.84	0.16	< 0.01	0.53	0.75
At first calving												
Numbers of AI	1.7	1.8	1.9	2.1	1.1	2.1	0.2	0.33	0.13	0.18	0.42	0.26
Age, months	22.3	22.8	22.6	22.7	22.4	22.8	0.3	0.83	0.90	0.21	0.53	0.73
First lactation												
305-day ME[4] milk, lb	30,393	31,560	31,709	31,165	28,785	32,542	879	0.92	0.46	0.06	0.77	0.04
305-day ME fat, lb	1,188	1,227	1,217	1,197	1,094	1,244	36	0.54	0.37	0.08	0.67	0.05
305-day ME protein, lb	897	922	886	906	852	939	21	0.46	0.99	0.02	0.44	0.18
Days open	103.1	98.2	89.3	112.2	95.1	119.8	9.1	0.82	0.68	0.26	0.24	0.99

Heifers born < 80 lb (LBW) were fed 9 pints/d of milk until they reached 80 lb, whereas high BW (HBW) heifers were fed 12 pints/d (HM). Heifers were uniformly managed after weaning.

[1]LBW = low birth weight, < 80 lb; HBW = high birth weight, ≥ 80 lb.

[2]Contrasts: TM, type of milk = MR vs. (PNSM + RNSM); Past, effect of pasteurization = PNSM vs. RNSM; BW, birth weight group = 9 vs. 12 pints/d based on BW until calves were ≥ 80 lb and were all fed 12 pints/d.

[3]HR = Hazard ratio describing the relative odds of weaning at this age; the RNSM-LBW group is the referent.

[4]ME = mature equivalent.

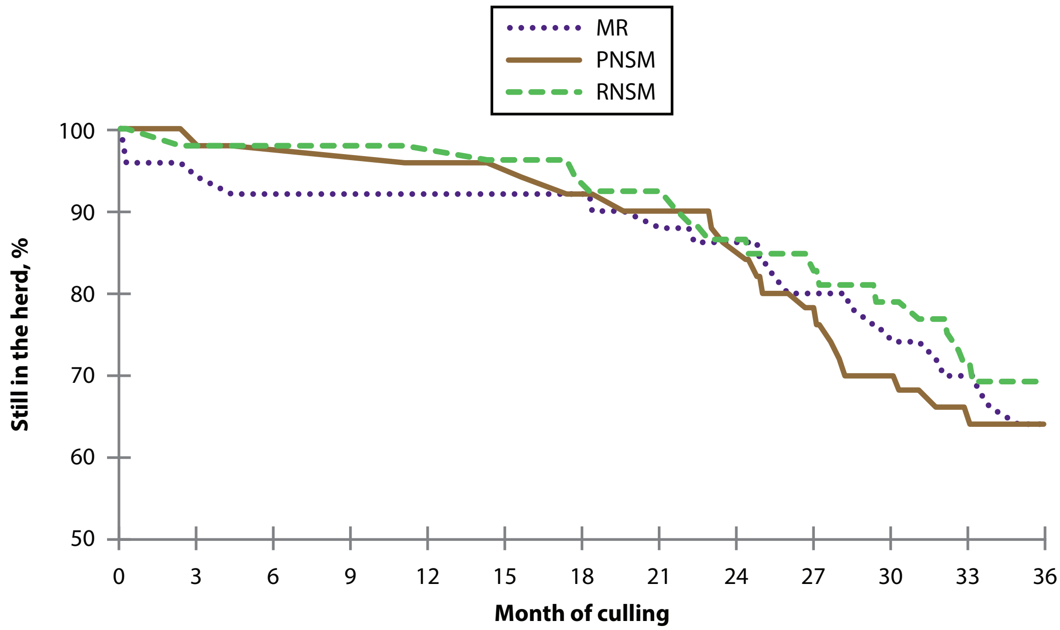

Figure 1. Retention in the herd of heifers fed milk replacer (MR), pasteurized or raw non-saleable milk (PNSM and RNSM, respectively) from birth to weaning (≥ 6 weeks). Heifers were uniformly managed after weaning. MR vs. (PNSM + RNSM), *P* = 0.92; PNSM vs. RNSM, *P* = 0.69.