Influence of Feeding Different Amounts of Milk on Performance, Health, and Absorption Capability of Baby Calves[1]

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ABSTRACT

The influence of feeding high milk on performance, health, and absorption capability of the small intestine was studied in Holstein calves (eight males and eight females). Animals were kept in outdoor hutches bedded with straw. Treatments consisted of two quantities of milk: 1) 4.1 kg of whole milk from 3 to 48 days of age when calves were weaned and 2) gradually increasing milk from 4.1 to 7.0 kg during the first 2 wk of treatment and feeding 7.6 kg per day thereafter until day 42. Milk was reduced gradually during the 7th wk. Intake of milk averaged 4.1 and 6.7 kg per animal per day. Commercial starter, alfalfa hay, and water were offered ad libitum to all calves.

Higher milk resulted in larger weight gains (615 versus 538 g/day) and less starter intake. Total dry matter intake, feed efficiency, and scour scores were not different between treatments, but rectal temperatures were greater on high milk. Female calves fed high milk showed less xylose absorption and more days medicated than females fed less milk.

INTRODUCTION

Nutrition of the calf during the milk feeding period is of a major importance in dairy production and has been subjected to intensive research.

For reasons of economics and to induce early consumption of solid food, whole milk equivalent to 8 to 10% of calf body weight has been recommended. This amount of milk is sufficient to support modest rate of gain (.3 to .4 kg per animal per day) to 3 wk of age (1). There are few reports on effects of high intake of milk on calf performance and health. Average daily weight gains of 1.1 kg were reported by Pettyjohn et al. (23) for calves fed milk replacers from 15 to 56 days of age. There have been similar results (7, 13).

High intake of milk often lowers consumption of solid food during the milk feeding period (10, 17, 25), which may explain the lower postweaning gain of calves reared on high milk compared to those fed less milk (4, 6, 15, 16, 21).

Another problem related to feeding large amounts of milk to baby calves is diarrhea (3, 9, 10), possibly related to abomasal overloading (3). In contrast, some reports did not find adverse effects of high milk on fecal consistency (8, 20, 28).

The objective of this experiment was to study effects of feeding large quantities of milk on calf performance, health, and absorption by gut.

MATERIALS AND METHODS

During the summer of 1981, 16 Holstein calves (8 males and 8 females) from the Michigan State University dairy herd were reared from birth to weaning at 7 wk of age. For the first 2 days of life, all animals were fed colostrum at 10% of body weight and 1 ml of Procain Penicillin G, 500,000 IU of vitamin A, and 75,000 IU of vitamin D. Calves were kept outdoors in hutches bedded with straw.

Treatment consisted of two quantities of milk (Table 1) fed twice daily, at 0700 and 1700 h. Commercial starter was offered for ad libitum intake from the 1st wk, and its daily intake was recorded. Alfalfa hay was available

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TABLE 1. Milk feeding schedule for baby calves fed two quantities of milk from 3 to 48 days of age.

Age	Treatment 1	Treatment 2
(days)	(kg/day)	
3 – 7	4.1	4.1
8 – 9	4.1	5.0
10 – 11	4.1	6.0
12 – 13	4.1	7.0
14 – 42	4.1	7.6
43 – 44	4.1	7.0
45 – 46	4.1	6.0
47 – 48	4.1	5.0

free choice, but intake was negligible and not recorded. Clean, fresh water was available at all times. Chemical compositions of milk, starter, and hay are in Table 2.

Calves were weighed individually for 3 consecutive days at the beginning and at the end of the trial. Weights also were taken at weekly intervals during treatment. Daily ratings for fecal consistency were on an index of 1 to 4 (14). Rectal temperatures also were recorded daily for each calf.

The xylose absorption test evaluated intestinal absorption ability of six calves from each treatment on their last day of the experiment. Calves were fasted 24 h, and D-xylose was given via nipple pail at .5 g/kg of body weight in a 10% aqueous solution. Jugular blood was sampled just before and at .5, 1, 1.5, 2, 2.5, 3, 4, and 5 h after ingestion of xylose. Xylose determinations in plasma were by orcinol/ferric chloride spectrophotometric method (26).

Initial body weights were analyzed as a complete randomized design and days of medication as contingency tables. All other variables were analyzed as split-plots (treatment as plots and time as subplots) as in Table 3. Tests for mean comparisons are indicated in table footnotes.

One female calf (treatment 1) died after 2 wk on experiment, and necropsy results indicated a congenital heart defect.

RESULTS AND DISCUSSION

Average initial body weights were similar between treatments, but males were heavier ($P<.05$) than females (Table 4). Treatment and sex effects on weight gain, intake of nutrients, feed efficiency, scour score, and rectal temperature are in Table 4.

Feeding more milk (treatment 2) resulted in higher ($P<.05$) weight gains, as did (12, 18, 22). However, starter intake was lower ($P<.05$) than controls (treatment 1), and total dry matter intakes were not different ($P>.05$) between treatments. Results were similar for (10, 15, 25). Feed efficiency was not different ($P>.05$) between treatments, which under normal prices would make feeding large amounts of milk to young calves uneconomical.

Diarrhea often is associated with higher intakes of milk (4, 9, 10, 11, 13, 19, 24, 27), although results also have been opposite (8, 20, 28). In this experiment, scour scores were not different ($P>.05$) between treatments. Sanitary and management conditions probably play a more important role than amount of milk in

TABLE 2. Chemical composition of feedstuffs.[1]

Feed	Dry matter (DM)	Crude protein	Ash	Fat
	(% of DM)			
Milk	11.33	28.07	7.24	32.39
Starter	86.51	19.26	9.84	3.18
Alfalfa hay	86.62	11.54	7.15	2.37

[1]Method described by Association of Official Analytical Chemists (2), except for milk crude protein and fat, which were determined by infrared absorption method through a Multispec instrument fabricated by Berwind Corporation.

TABLE 3. Analysis of variance of performance criteria.

Sources of variation	df	Mean squares: Weight gains	Dry matter intake: Milk	Dry matter intake: Starter	Dry matter intake: Total	Feed efficiency	Total protein intake	Scour scores	Rectal temperature
Treatment (T), %	1	.164	2.634**	1,383,950**	.119	.04	77,240**	2.34	.77*
Animal/T (Error a)	14	.062	.016	146,705	.189	.07	8,117	1.66	.11
Sex (S)	1	.031	.015**	82	.013	.01	3,205	.15	.01
Weeks (W)	6	2.303**	.221**	2,408,256**	3.015**	.68**	109,742**	4.36**	.18*
T X S	1	.124	.016**	26	.029	.11	3,045	.66	.02
T X W	6	.201	.221**	133,158**	.089	.19	10,713**	.11	.10
S X W	6	.074	.005**	3,471	.011	.13	1,934	.06	.03
T X S X W	6	.035	.004**	6,688	.001	.04	2,066	.53	.02
Error b	70	.101	.001	33,318	.038	.16	1,832	.32	.06

*P .05.

**P .01.

TABLE 4. Influence of treatment and sex on average daily gains, intake of nutrients, feed efficiencies, scour scores, and rectal temperatures of calves.

Variables	Treatments: 1	Treatments: 2	SE	Sexes: Males	Sexes: Females	SE
Initial body weight, kg	42.3^{a}	43.6^{a}	1.5	45.0^{a}	40.9^{b}	1.5
Average daily gain, g/animal per day	538^{b}	615^{a}	33	593^{a}	560^{a}	42
Milk intake, g dry matter/animal per day	462^{b}	769^{a}	17	627^{a}	604^{b}	4
Starter intake, g dry matter/animal per day	515^{a}	292^{b}	51	403^{a}	404^{a}	24
Total intake, g dry matter/animal per day	977^{a}	1,061^{a}	58	1,030^{a}	1,008^{a}	26
Weight gain/dry matter intake	.55^{a}	.58^{a}	.04	.58^{a}	.56^{a}	.05
Total protein intake, g/animal per day	216^{b}	268^{a}	12	247^{a}	237^{a}	6
Scour score	2.3^{a}	2.6^{a}	.2	2.5^{a}	2.4^{a}	.1
Rectal temperature, °C	38.94^{b}	39.10^{a}	.04	39.03^{a}	39.01^{a}	.03

^{a,b}Means in the same row, within treatments and sexes, not sharing the same superscript differ (P<.05) (Dunnett's test).

TABLE 5. Influence of age (weeks) on average daily gains, feed intake, feed efficiencies, scour scores, and rectal temperatures of calves fed different amounts of milk.

		Weeks							
Variables	Treatment	1	2	3	4	5	6	7	SE
Average daily gain, g/animal per day	1 & 2	97^{e}	144^{de}	373^{d}	685^{c}	888^{ab}	755^{b}	$1,091^{a}$	79
Milk intake, g dry matter/animal per day	1	462^{a}	462^{a}	462^{a}	462^{a}	462^{a}	462^{a}	462^{a}	11
	2	463^{e}	$578^{d,A}$	$831^{c,A}$	$870^{c,A}$	$958^{b,A}$	$1,106^{a,A}$	$575^{d,A}$	11
Starter intake, g dry matter/animal per day[1]	1	7^{f}	72^{f}	247^{e}	424^{d}	655^{c}	948^{b}	$1,249^{a}$	65
	2	0^{d}	35^{d}	$93^{d,A}$	$235^{c,A}$	$329^{b,c,A}$	$419^{b,A}$	$935^{c,A}$	65
Total dry matter intake, g/animal per day	1 & 2	466^{d}	574^{d}	816^{c}	995^{c}	$1,202^{b}$	$1,468^{a}$	$1,611^{a}$	49
Weight gain/dry matter intake	1 & 2	$.27^{b}$	$.25^{b}$	$.46^{ab}$	$.70^{a}$	$.75^{a}$	$.50^{ab}$	$.70^{a}$	.10
Total CP[2] intake, g/animal per day[1]	1	131^{f}	142^{f}	171^{e}	201^{d}	240	289^{b}	339^{a}	15
	2	130^{e}	168^{d}	$249^{c,A}$	$284^{b,A}$	324^{c}	$406^{a,A}$	318^{b}	15
Scour scores	1 & 2	1.5^{d}	3.0^{a}	2.9^{a}	2.3^{bc}	2.8^{ab}	2.3^{bc}	2.2^{c}	.1
Rectal temperature, °C	1 & 2	38.91^{b}	39.16^{a}	39.01^{ab}	38.91^{b}	38.97^{ab}	38.97^{ab}	39.16^{a}	.06

^{a,b,c,d,e,f}Means in the same row with unlike superscripts differ ($P<.10$) by Tukey's test.

^{A}Different from control (treatment 1) at $P<.05$ by Dunnett's test, within each variable.

[1] Means are separate for treatments 1 and 2 because interaction treatment × age was significant ($P<.01$).

[2] CP = Crude protein.

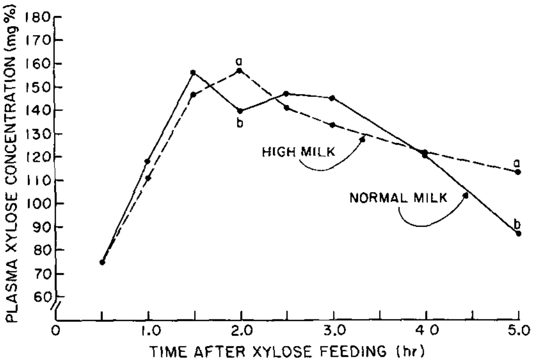

Figure 1. Mean plasma xylose concentrations after an oral dose of xylose in calves fed different amounts of whole milk. Points within a time with unlike letters are different (*P*<.01).

incidence of diarrhea in young calves. Rectal temperatures were higher (*P*<.05) in calves fed more milk suggesting more stress, although they were in the normal range for both treatments.

Male calves showed higher (*P*<.05) average intake of milk than females, probably because they were heavier and the feeding criterion of treatment 2 was based on body weights. Average daily gain, feed efficiency, scour score, and rectal temperatures also tended to be higher for males, but not significant (*P*>.05).

Age effects on weight gains, feed intake, feed efficiency, scour scores, and rectal temperatures are in Table 5. As expected, all variables were influenced (*P*<.10) by age (Table 3). Average daily gains increased (*P*<.10) with age, reaching 1.0 kg when calves were 7 wk old. Gains of .8 to 1.0 during the entire milk-feeding period for calves fed whole milk or milk replacers ad libitum (13, 18, 20, 23, 25) were not in this experiment. However, these high rates of gain usually were in 9 to 14 wk experimental periods compared to 7 wk for our study.

The interaction, treatment × age, was significant (*P*<.01) for milk (imposed by treatment), starter, and total crude protein intake (Table 3). Starter intake increased (*P*<.10) with age in both treatments but only after the 3rd wk. Calves fed restricted milk showed faster (*P*<.05) increase of starter intake than those fed liberal milk (Table 5). This may explain the slower postweaning gain of calves fed high milk until weaning (12, 16). As concluded by Le Du et. al. (15), calves receiving high milk will experience a more severe check of live weight gain after weaning, which may nullify better gains between birth and weaning. Total crude protein intake increased (*P*<.10) with age in both treatments but increased faster on high milk because of greater dry matter intakes. Feed efficiency also improved (*P*<.10) with age as expected. Scour scores and rectal temperatures were highest (*P*<.10) for wk 2 and 3 but decreased as calves grew older.

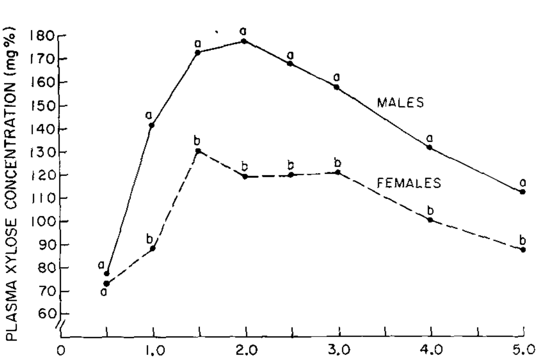

Figure 2. Mean plasma xylose concentrations after an oral dose of xylose in male and female calves fed different amounts of whole milk. Points within a time with unlike letters are different (*P*<.01).

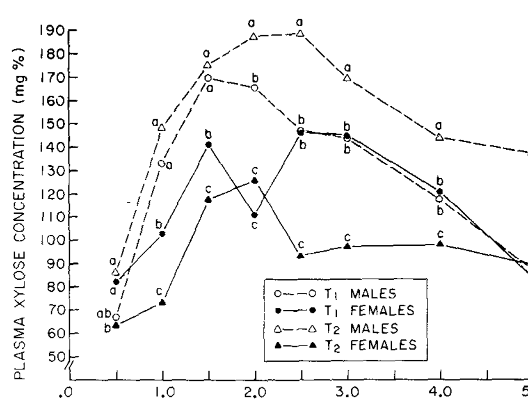

Figure 3. Mean plasma xylose concentrations after an oral dose of xylose in calves of both sexes fed different amounts of whole milk. Points within a time with unlike letters are different (*P*<.01). T-1 is normal milk and T-2 is high milk.

TABLE 6. Influence of treatment and sex on number of days calves were medicated.

	Males		Females		Combined sex	
Treatment[a]	Medicated[b]	Unmedicated[c]	Medicated[b]	Unmedicated[c]	Medicated[b]	Unmedicated[c]
1	24	172	26	170	50	342
2	24	172	36	160	60	332

[a]For females, days medicated was higher for treatment 2 ($P<.10$), but there was no difference between males.

[b]Days that calves received medication (treated mostly for mild diarrhea with "Life Guard," a glucose and electrolyte oral rehydrating solution; Norden Lab., Lincoln, NE).

[c]Days that no medication was administered.

Number of days that calves received medication are in Table 6. Most treatments were for mild diarrhea with an oral glucose and electrolyte solution. Days on medication were independent of sex for the group on less milk, but when large amounts of milk were fed, days on medication were higher ($P<.10$) for females than for males, suggesting that high milk was more stressful to heifers than bulls.

The xylose absorption test was applied to three males and three females from each treatment to determine if higher milk in early life affected absorptive capability of the intestine. As observed by Seegraber and Morrill (26), plasma xylose concentrations peaked 1.5 to 2.0 h after xylose ingestion, then decreased. Curves were similar for both treatments (Figure 1), but calves fed higher milk (treatment 2) showed higher ($P<.01$) plasma xylose at 5 h after xylose ingestion. This observation is probably due to slower xylose clearance from plasma in calves fed high milk. Clearance was also slower for calves fed soy protein concentrate and spray-dried fish solubles compared to all milk protein (5).

Male calves showed higher ($P<.10$) plasma xylose curves than females (Figure 2), suggesting than higher weight gains traditionally in males may be related to greater absorption capability of the intestine. Figure 3 shows an interaction between treatment and sex ($P<.01$) for xylose absorption curves. Male calves showed higher plasma xylose when fed liberal amounts of milk, whereas female calves showed lower ($P<.01$) xylose when fed high milk. This finding might relate to more days on medication for females on high milk and signal greater sensitivity of females than males fed liberal amounts of milk in early life. Increasing whole milk for young dairy calves raised in outdoor hutches from 4.1 to 7.6 kg per day increased weight gains 14%, decreased starter intakes 43%, but efficiency of feed utilization and scour scores were not altered even though rectal temperatures were higher for high milk.

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