Intake, Growth, and Selected Blood Parameters in Calves Fed Calf Starter via Bucket or Bottle[1]

J. D. QUIGLEY, III, J. K. BERNARD,
T. L. TYBERENDT, and K. R. MARTIN
Institute of Agriculture
Department of Animal Science
University of Tennessee
Knoxville 37901-1071

ABSTRACT

Calf starter was offered to 40 calves in a plastic bucket or from a nipple bottle, and intake, growth, and selected blood parameters were measured. The nipple was designed with a large opening to allow feed particles to pass through the nipple during meals. Calves began the study at 7 d of age and were fed for 56 d. A commercially prepared calf starter was offered for ad libitum consumption from d 1 of the study, and commercial milk replacer was offered at 10% of BW to weaning at 6 wk of the study. No effects of treatment on intake, rates of gain, feed efficiency, blood BHBA or plasma glucose, urea N, or NEFA were observed. Consumption of starter DM exceeded 1.9 kg/d by wk 8 of the study. Concentration of blood parameters changed in a fashion consistent with developing ruminal function. Calf starter fed from a plastic nipple bottle promoted starter intake as effectively as did starter fed from plastic buckets.

(**Key words**: calves, intake, calf starter)

INTRODUCTION

Reducing the age at which calves are weaned generally is more cost effective than delaying weaning, improves calf health, and reduces costs associated with increased morbidity and mortality. Calves have been weaned early by promoting early intake of dry feed by addition of prestarters to milk (1) or by calf starter (5) or prestarter (8) fed in plastic bottles fitted with large nipples designed to allow small feed particles to pass when the calf nurses (Braden Start Bottle; Braden Industries, Sulphur Springs, TX). Use of nipple bottles to promote early grain intake generally has been successful. McGahee et al. (5) and Quigley et al. (8) reported earlier initiation of grain intake when grain was offered through nipple bottles compared with grain fed in open buckets, although rates of gain were unaffected in both studies. Because initiation of dry feed intake is requisite for development of ruminal function (1, 9, 11), calves consuming feed at an earlier age may be prepared sooner for weaning, thereby reducing overall costs to the dairy enterprise.

In other reports using plastic nipple bottles (5, 8), calves fed starter from bottles were weaned at different ages than calves fed from buckets. Whether use of bottles in a conventional feeding program affects intake, rates of gain, or feed efficiency is not clear. Therefore, our objective was to measure intake, gain, and feed efficiency in calves fed calf starter from plastic nipple bottles or from buckets.

MATERIALS AND METHODS

Calf Assignments and Design

Forty Holstein calves (20 bulls and 20 heifers) were blocked by sex and calving date and assigned randomly within blocks to a 2 × 2 factorial arrangement of housing (an unheated calf barn or individual hutches) and method of feeding (plastic bucket or nipple bottle). Maternal colostrum (2 L) was fed as soon as possible after birth and 12 h later. The BW of each calf was recorded, and the navel was dipped in

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[1]Mention of trademark, proprietary product, or vendor does not constitute an endorsement, guarantee, or warranty of the product by The University of Tennessee and does not imply its approval to the exclusion of other products or vendors that also may be suitable.

TABLE 1. Chemical composition of milk replacer and calf starter used in the study.

Item	Milk replacer[1]		Calf starter[2]	
	$\overline{X}$	SE	$\overline{X}$	SE
DM, %	94.7	.2	89.7	.3
	(% of DM)			
CP	23.1	.2	19.5	.2
Ash	10.0	.3	8.4	.2
NDF	ND[3]		12.8	.4
Ca	.57	.01	1.40	.08
P	.81	.01	.94	.01

[1]n = 5.

[2]n = 6.

[3]Not determined.

iodine solution prior to beginning the study. Milk replacer was offered twice daily until calves were assigned to the study at 7 d (SE = .4) of age. Calves were fed a commercially prepared pelleted calf starter (Braden Bottle Calf Starter Pellets with Calf Manna; Manna Pro, St. Louis, MO). Bottles were hung from the side of each stall or hutch according to manufacturer's recommendations. Calf starter was fed once daily for ad libitum consumption throughout the study. Calves were fed commercial milk replacer (Maxi-Lac; Tennessee Farmers Cooperative, LaVergne, TN) twice daily at 10% of BW to weaning at 42 d of the study. Amount of milk replacer offered was adjusted weekly. Water was available at all times.

Sampling and Data Collection

Calves were weighed at the beginning of the study and every 7 d thereafter to 56 d. Intakes of calf starter and milk replacer were measured daily and recorded weekly. Starter and milk replacer were sampled weekly and composited monthly for analysis of DM, CP, ash (2), NDF (4, 10), Ca, and P (atomic absorption spectrophotometry). Incidences of health problems were recorded for each calf.

Jugular blood (approximately 10 ml) was collected approximately 4 h after the a.m. feeding at 0, 2, 4, 6, and 8 wk of the study. A 2-ml subsample was deproteinated immediately with 2 ml of 1 *M* $HClO_4$ and placed on

TABLE 2. Least squares means of BW, average daily gain (ADG), DMI, CP intake (CPI), intake of calf starter and milk replacer DM, and feed efficiency in calves fed calf starter from plastic buckets or plastic nipple bottles.

Week	BW		ADG		DMI		CPI		Starter		Milk		ADG:DMI[1]	
	Bottle	Bucket	Bottle	Bucket	Bottle	Bucket	Bottle	Bucket	Bottle	Bucket	Bottle	Bucket	Bottle	Bucket
	(kg)		(g)		(g/d)									
1	40.5	42.5	−133	−55	564	563	128	127	75	85	489	478	−253	−108
2	41.4	43.2	137	92	607	585	136	131	123	106	483	479	91	108
3	44.0	45.8	372	372	839	815	182	178	331	283	508	531	439	445
4	48.2	50.4	594	669	1101	1092	234	233	555	537	547	556	579	619
5	52.8	55.6	665	734	1431	1369	300	289	832	744	598	625	456	536
6	58.1	60.5	751	696	1672	1648	349	345	1026	986	646	662	465	407
7	61.6	63.8	509	481	1653	1632	323	318	1653	1632	0	0	302	294
8	65.8	68.7	597	700	1913	1997	373	389	1913	1997	0	0	276	369
SE		2.0		80		77		15		69		19		91

[1]Grams of ADG per kilogram of DMI.

ice prior to analysis of BHBA (12). Remaining blood was added to 400 μl of 6% EDTA prior to separation of plasma and analysis of glucose (glucose kit 510; Sigma Chemical Co., St. Louis, MO), urea N (urea kit 640; Sigma Chemical Co.), and NEFA (NEFA-C kit; Wako Pure Chemicals, Osaka, Japan).

Statistical Analysis

Data were analyzed as a repeated measures experimental design using a general linear mixed model algorithm (3). The model was $Y_{ijk} = \mu + B_i + T_j + BT_{(ij)} + W_k + WT_{(jk)} + e_{(ijk)}$, where Y_{ijk} = observation; μ = overall mean; B_i = effect of block i (i = 1 . . . 10); T_j = effect of treatment j (j = 1 . . . 4); $BT_{(ij)}$ = effect of block × treatment interaction; W_k = effect of week k (k = 1 . . . 8 for BW, intake, and feed efficiency; 1 . . . 4 for blood data); $WT_{(jk)}$ = effect of week × treatment interaction; and $e_{(ijk)}$ = error. Block × treatment interaction was used to test effects of treatment. Orthogonal contrasts were used to differentiate effects of housing, feeding method, and interaction. Significance of $P < .05$ was used unless otherwise noted.

RESULTS AND DISCUSSION

Calves generally were healthy throughout the study. Incidence of disease was minimal and unrelated to treatment. Two calves died during the study and were not replaced; therefore, least squares means are presented. Calf starter contained more CP than formulated (Table 1); consequently, protein intake exceeded NRC (6) recommendations throughout the study.

No effects of housing or feeding method were observed on BW, average daily gain, intake of starter, milk replacer, DM, CP, or feed efficiency (Table 2). Although others reported increased intake of starter (5) or prestarter (8) prior to weaning, no effect of method of feeding on starter intake was observed during the first few weeks of the study. Intake of starter between treatments groups varied by 10, 17, and 48 g/d during the first 3 wk of the study, respectively. Starter consumption exceeded 1.9 kg/d of DM from bottles and buckets by the last week of the study. Although calves may have difficulty obtaining large amounts of starter from the nipple, these data suggest that intake up to 1.9 kg/d of DM (2.1 kg/d as fed) was not limited by method of feeding.

Calves lost BW during wk 1 of the study, apparently because of stress of changes in management at the initiation of the study. Thereafter, rates of BW gain were positive and peaked at 724 g/d during wk 6. Weaning reduced average daily gain and feed efficiency during wk 7 and 8.

All measured blood parameters were unaffected by treatment (Table 3). Concentration of blood BHBA increased ($P < .01$) as starter intake increased and then increased by 39 and 34% at wk 6 and 8, respectively. Blood BHBA was somewhat higher prior to weaning than in previous studies (7); rate of change was consistent with increasing dry feed intake. Plasma glucose declined until weaning, and plasma urea N increased ($P < .01$) markedly at wk 8. Plasma NEFA declined linearly with increasing age. All metabolites indicated a transition at weaning (7) as calves began to rely on ruminal fermentation to supply a significant

TABLE 3. Concentration of blood BHBA, plasma glucose, plasma urea N (PUN), and plasma NEFA in calves from 2 to 8 wk of the study.

Week	BHBA		Glucose		PUN		NEFA	
	Bottle	Bucket	Bottle	Bucket	Bottle	Bucket	Bottle	Bucket
	(mM)							
2	.404	.427	4.70	4.56	3.82	3.22	.231	.204
4	.474	.446	4.32	4.21	3.52	3.80	.201	.167
6	.628	.651	3.46	3.76	3.56	3.91	.119	.141
8	.870	.849	3.85	4.13	5.98	6.11	.107	.109
SE	.047		.14		.25		.011	

amount of energy and protein for maintenance and growth. Lack of difference between treatments indicated that the method of feeding calf starter did not affect ruminal development.

CONCLUSIONS

Braden Start Bottles are an acceptable replacement for plastic buckets for feeding starter to calves up to 8 wk of age. Intake, growth, and feed efficiency were unaffected when bottles were used. This method of feeding management may be particularly effective when calf starter is exposed to moisture or insects or when calf starter is not replaced daily.

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REFERENCES

1 Anderson, K. L., T. G. Nagaraja, and J. L. Morrill. 1987. Ruminal metabolic development in calves weaned conventionally or early. J. Dairy Sci. 70:1000.

2 Association of Official Analytical Chemists. 1980. Official Methods of Analysis. 13th ed. AOAC, Washington, DC.

3 Blouin, D. C., and A. M. Saxton. 1990. General linear mixed models (GLMM) user's manual. Agric. Exp. Stn., Louisiana State Univ., Baton Rouge.

4 Goering, H. K., and P. J. Van Soest. 1970. Forage Fiber Analyses (Apparatus, Reagents, Procedures, and Some Applications). Agric. Handbook No. 379. ARS-USDA, Washington, DC.

5 McGahee, M. W., D. W. Kellogg, P. R. Webb, and Z. B. Johnson. 1992. Use of a dry bottle to feed starter grain to Holstein calves. Prof. Anim. Sci. 8(3):22.

6 National Research Council. 1989. Nutrient Requirements of Dairy Cattle. 6th rev. ed. Natl. Acad. Sci., Washington, DC.

7 Quigley, J. D., III, L. A. Caldwell, G. D. Sinks, and R. N. Heitmann. 1991. Changes in blood glucose, nonesterified fatty acids, and ketones in response to weaning and feed intake in young calves. J. Dairy Sci. 74:250.

8 Quigley, J. D., III, S. A. Nagel, and J. K. Bernard. 1992. Intake, growth, and weaning age of calves fed a preweaning supplement via bucket or bottle. Prof. Anim. Sci. 8(4):17.

9 Quigley, J. D., III, C. G. Schwab, and W. E. Hylton. 1985. Development of rumen function in calves: nature of protein reaching the abomasum. J. Dairy Sci. 68:794.

10 Robertson, J. B., and P. J. Van Soest. 1977. Dietary fiber estimation in concentrate feedstuffs. J. Anim. Sci. 44(Suppl. 1):256.(Abstr.)

11 Sutton, J. D., A. D. McGilliard, M. Richard, and N. L. Jacobson. 1963. Functional development of the rumen. II. Metabolic activity. J. Dairy Sci. 46:530.

12 Williamson, D. H., and J. Mellanby. 1965. Acetoacetate and D-(-)-β-hydroxybutyrate. Page 454 *in* Methods of Enzymatic Analysis. 2nd ed. H. V. Bergmeyer, ed. Academic Press, New York, NY.