Feeding of Cold Whole Milk Once Daily to Calves in a Group and Its Effect on Calf Performance, Health, and Labour Input

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ABSTRACT

Female calves (n = 54) were assigned to 1 of 3 whole milk feeding treatments at an average age of 7 days and remained on treatment for 70 days. The treatments were twice-a-day feeding with weaning at 56 days of age (TAD56); once-a-day feeding with weaning at 56 days of age (OAD56); and once-a-day feeding with weaning at 42 days of age (OAD42). Calves were housed in groups of 9 and were fed 5 litres of cold whole milk daily using teat feeders and offered ad libitum calf starter concentrate. The calf performance, health, and feed intakes were recorded and labour input per treatment was measured. The overall weight gain was 48.3, 47.3, and 47.1 kg/calf with TAD56, OAD56, and OAD42, respectively, over 70 days. The total concentrate intake and the corresponding total milk dry matter intake for 70 days were 82.3, 80.4, and 91.0 kg/calf and 32.4, 32.4, and 24 kg/calf for TAD56, OAD56, and OAD42, respectively. The labour input per calf per day was higher for TAD56 (88 sec) compared to OAD56 (66 sec) or OAD42 (53 sec) feeding systems. More group outbreaks of diarrhea were observed with once-a-day feeding and these outbreaks coincided with periods of cold weather. This study demonstrated that calves fed on a group basis once daily and weaned at 42 days may be reared successfully in terms of performance health and labour input.

INTRODUCTION

Rearing the pre-weaned calf is one of the most challenging tasks on the dairy farm, particularly with a spring milk production system, where 90% of calves are born over a 12-week period. The labour requirement associated with calf rearing accounts for an average 0.13 of all labour associated with the dairy enterprise during this period.[1] The labour requirement for calf rearing may be reduced by selecting different calf feeding methods such as the use of ad libitum systems instead of bucket feeding systems.[2,3] Kung et al[4] recorded a lower labour input with calves reared in group pens compared to those in individual pens. Teat feeding systems are more commonly used when calves are group fed. Teat feeding makes group feeding of calves easier[5] and results

in less inter calf suckling.[6,7] Similar calf performance has been observed when calves were fed milk by teats and individual bucket.[8] Grouping of calves has been shown to have advantages in terms of weight gain after weaning over those fed individually.[9] From a welfare perspective, there is a preference for calves to be group penned. The length of time calves are fed milk prior to weaning has been investigated by many researchers, with the general consensus that calves can be weaned at fairly early ages without affecting performance.[10-12] While not affecting performance, early weaning may offer a reduction in the labour input for calf care and a reduction in the cost of rearing. Feeding calves milk once daily in individual pens has been shown not to adversely affect calf performance.[13,14] Studies by Fallon et al[15] have indicated that calves do not experience a severe nutrient deprivation on being introduced to this feed regime. Most studies on once-daily feeding have investigated the effect of feeding milk replacer to calves individually and there is limited knowledge on feeding whole milk to calves as a group. Furthermore, no difference in calf weight gain was observed when calves were fed cold milk replacer (room temperature) compared to warm milk (38°C).[8] Feeding cold milk to calves has also been shown to increase concentrate intake and reduce milk intake.[16] The feeding of cold milk to calves offers the opportunity for milk feeding to be carried out at an off-peak time during the working day. If once-daily cold milk feeding were used in conjunction with grouping of calves, considerable labour savings could be achieved. There is little information on the effect of this management practise on calf performance, calf health, and labour input. The objective of this study was to evaluate the effect of group feeding whole milk to calves either once or twice daily with respect to calf performance, health, and labour input.

MATERIALS AND METHODS

Female calves (n = 54) were randomly assigned to 1 of 3 milk feeding treatments at an average age of 7 days and remained on treatment for 70 days. The treatments were twice-a-day milk feeding with weaning at 56 days of age (TAD56); once-a-day feeding with weaning at 56 days of age (OAD56); and once-a-day feeding with weaning at 42 days of age (OAD42). Calves were randomized and assigned to treatment based on date of birth, calf live weight, and sire breed. Sire breed types on each treatment were Holstein Friesians (n = 12), New Zealand × Friesians (n = 4) and Montebelliarde × Friesians (n = 2). Immediately following birth, all calves were offered an adequate volume of colostrum twice daily and all navels were dressed with an iodine solution. Calves were housed individually until assigned to treatment and then were placed in group pens containing 9 calves. Each group pen was filled with calves within 2 days and each treatment group was replicated. Calves remained indoors in the group pens for 70 days. From Day 70 until Day 233, calves were managed as 1 group outdoors mainly on a grass diet. From Day 233 to 338, indoors calves were managed mainly on a silage diet in equal numbers at 2 separate locations. From Day 338 to Day 351 (mating start day), heifers were managed as 1 group on a grass diet.

Feeding Methods

All calves were fed whole milk at 0900h and calves fed twice daily were fed their second feed at 1530h. Milk from the farm bulk tank was transported by mobile tank (milk temperature ranged from 4°C to 10°C) to the calf house. There were no acidifiers or additives added to the milk before feeding to the calves. Calves which were offered milk twice daily received 2.5 litres of milk at each feeding time. Calves that were offered milk once daily received 5 litres of milk at the morning feeding time. Calves in each group pen were offered milk using a teat feeder (12 teats). The teat feeders, which did not contain individual chambers, were attached to the front gate of each pen. Teat feeders were left in each pen for approximately 5 min after milk had been consumed to reduce cross-suckling. Teat feeders were

then removed and washed. Calves offered milk twice daily and once daily for 56 days had their total daily milk volume reduced gradually from 5 to 1 litre per day starting at Day 50 until weaning. Calves offered milk once daily for 42 days had their total daily milk volume reduced gradually from 5 to 1 litre per day starting at Day 36 until weaning. Calves were fed a commercially available calf starter ration that was flaked and available to calves ad libitum throughout the 70-day experimental period. This ration was fed daily in a feed trough attached to the side of the pen. The ration contained barley, soya, flaked maize, sunflower seed, lucerne, calcium carbonate, beet pulp molasses, wheat, and sodium bicarbonate (protein 18%, oil 3.5%, fibre 6.0%, ash 8.0%, moisture 14%, vitamins A and D3). Perennial ryegrass hay was offered ad libitum to calves from Week 4. Self-filling fresh water troughs were located in each of the group pens. Calves were housed in what could be considered a cold naturally ventilated house. Calves were bedded using sawdust and beds were topped up with sawdust if they appeared soiled or wet. The amount of sawdust added to each pen was recorded so that total bedding requirements per calf could be calculated. The total pen area available per calf was 2.62 m. The mean calf house temperature recorded daily at 0900h was 5.8°C and varied between -1.5°C and 12°C. The average temperature of the milk offered to calves was 5.7°C and varied between 2.7°C and 7.4 °C.

Measurements

Individual calf live weight was recorded using a mobile weighing scale at the start day and fortnightly thereafter at 1400h, until Day 70. Calves were subsequently weighed at mating start day (average day = 351). Weekly group intake and weigh backs of concentrate were recorded. The total quantity of hay consumed per pen was recorded over the 70-day period. The dry matter (DM) of the milk fed to calves was calculated weekly using International Dairy Federation (IDF) (21B:1987) methods for determination of milk solids in milk. Daily health parameters recorded included the incidence of individual calf diarrhoea, group diarrhoea, bloat, pneumonia, navel ill, and calf deaths. Individual calves with diarrhoea were taken off milk for a 3-day period and fed twice daily with 2.5 litres of an electrolyte solution. When a pen of calves were observed with diarrhoea, milk was withdrawn for 24 hours and calves were fed twice daily with 2.5 litres per calf of an electrolyte solution. On the second day, calves were offered 2.5 litres of an electrolyte solution and 2.5 litres of milk with electrolytes added. Calves were returned to the normal feed on the third day.

The hind quarters of each individual calf was scored for the presence and texture of faeces to indicate any possible affects of milk feeding on rumen digestion. The hind quarters were categorised into 7 different areas (tail head, tail, tail end, rump, above hock, hock, and below hock). Scoring was carried out by 1 operator at Day 1 and weekly for 8 weeks. The scoring scale was: 1 = normal, clean with no faeces; 2 = dry solid faeces; and 3 = wet faecal matter.

Labour Requirements

The labour input per day associated with all tasks related to calf care for each treatment was recorded by 1 operator using a stop watch on 15 occasions during the 70-day experimental period. The calf care tasks included: milk transfer to the calf house, calf feeding, cleaning feeding equipment, pen bedding/cleaning, and concentrate/hay feeding. The time required for veterinary attention to attend to the health incidences observed was calculated based on additional time that may be required above the normal daily feeding time.

Statistical Analysis

Data were analysed using mixed models with Proc mixed (SAS, 2006). Time period was included as the repeated effect with calf and pen included as a random effect. Average daily gain for the rearing period of 70 days is the difference in weight between 2 time periods divided by the respective num-

ber of days. Average daily gain for the rearing period from weaning to mating start date and mean live weight at mating was tested and adjusted for the fixed effects of calf birth day and differences in diet during the winter period. Birth day had no effect on either live weight or average daily gain, whilst diet had a significant effect. Calf dirtiness data were analysed by the Kruskal Wallis test using the non-parametric procedure of SAS (Proc NPar1Way). Where treatment differences were found, the Mann Whitney test was used for post hoc analysis.

RESULTS

Live Weight

There were no differences in the total live weight of calves at any weighing date or at Day 70 (Table 1). The overall weight gain was 48.3, 47.3, and 47.1 kg/calf for TAD56, OAD56, and OAD42 treatments, respectively.

Daily live weight gain was similar for all treatments for the different time periods and over the 10 weeks. The ADG from Day 0 to weaning was 0.69, 0.68, and 0.67 kg/calf for TAD56, OAD56, and OAD42 treatments, respectively.

OAD42 calves were weaned from milk at a lower live weight (63.7 kg) than TAD56 (77 kg) or OAD56 (77 kg) calves. The lower weaning weight had no affect on calf live weight at Day 70. The mean weight at mating start date was 352, 350, and 356 kg/calf for TAD56, OAD56, and OAD42 treatments, respectively. The ADG from weaning to mating start date was 0.75, 0.75, and 0.77 kg/calf for TAD56, OAD56, and OAD42 treatments, respectively.

Feed Intake

Higher intakes of concentrates were observed for OAD42 calves compared to OAD56 or TAD56 calves for Weeks 7 and 8 (Figure 1) due to withdrawal of the milk feed. No differences in intakes were observed between treatments prior to weaning (Weeks 1 to 6) and during Weeks 9 and 10 when all calves were weaned. The total concentrate intake per calf for 70 days was 82.3, 80.4 and 91.0 kg for TAD56, OAD56, and OAD42 feeding systems, respectively.

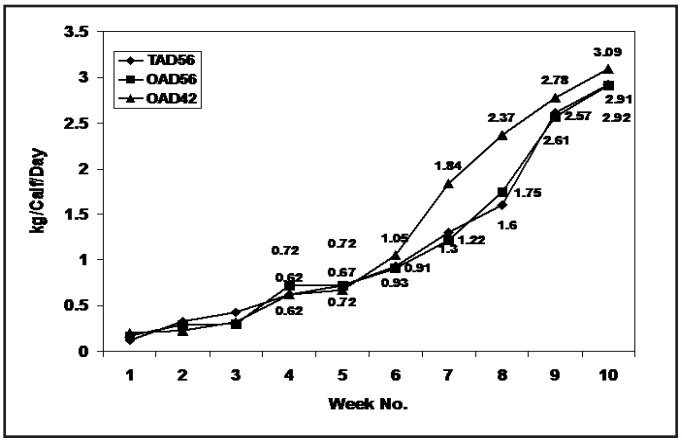
The frequency of milk feeding or time of weaning had no effect on the intake of hay. OAD42 calves consumed less milk (24.0 kg/DM) than TAD56 or OAD56 (32.4 kg/DM

Table 1. Live Weight (LW) (kg) and Average Daily Gain (ADG) (kg) for Calves Offered Milk Either Twice Daily (TAD) and Weaned at 56 Days or Once Daily (OAD) and Weaned at Either 56 or 42 Days.

	TAD56 (n = 16)		OAD56 (n = 16)		OAD42 (n = 16)		LW		ADG	
Day	LW	ADG	LW	ADG	LW	ADG	SE	Significance	SE	Significance
0	42.4	—	42.2	—	42.4	—				
14	47.6	0.38	47.5	0.37	50.4	0.58	1.88	NS	0.69	NS
28	54.5	0.49	56.9	0.68	55.8	0.38	1.88	NS	0.69	NS
42	64.9	0.74	66.4	0.67	63.6	0.56	1.88	NS	0.69	NS
56	76.7	0.84	71.5	0.79	76.9	0.95	1.88	NS	0.69	NS
70	90.7	1.00	89.5	0.85	89.5	0.89	2.50	NS	0.69	NS
ADG (0-70 days)		0.69		0.68		0.67			0.05	NS
Mating start (351 days)	353		357		361		5.97	NS		
ADG (wean-351 days)		0.75		0.75		0.77			0.02	NS

n = number of calves; SE = standard error.

Figure 1. Daily calf intake of concentrate.



each) calves (Table 2). There were marginal differences in the consumption of hay between feeding systems. OAD42 calves consumed 1.4 kg/calf more hay than TAD56 and 0.7 kg/calf more hay than OAD56 calves from Day 28 to Day 70. When the DM content was calculated for each feed type (milk, 12.4% solids; concentrate, 87%; and hay, 95%), there were no differences in the overall DM intake between feeding systems. Total DM intakes for 70 days were 110.6, 108.5, and 111.1 kg per calf for TAD56, OAD56, and OAD42 feeding systems, respectively.

Sawdust and Labour Requirements

There were little differences in the total quantity of sawdust required for bedding between feeding systems. The total amount of sawdust required was 137, 143, and 145 kg for TAD56, OAD56, and OAD42 feeding systems, respectively. The labour input per calf per day was higher for TAD56 (88 sec) compared to OAD56 (66 sec) or OAD42 (53 sec) feeding systems (Table 3). Differences in labour input were recorded for the individual tasks of milk transfer, feeding, and cleaning equipment over the 70-day rearing period. OAD42 had the lowest time per calf per day for these combined tasks (27 sec) compared to OAD56 (35 sec) or TAD56 (57 sec).The time for veterinary attention did not differ between feeding systems.

Table 2. Total Dry Matter (DM) Intake of Milk, Concentrate, and Hay Over 70 Days for Calves Offered Milk Either Twice Daily (TAD) and Weaned at 56 Days or Once Daily (OAD) and Weaned at Either 56 or 42 Days.

	TAD56 (n = 16)	OAD56 (n = 16)	OAD42 (n = 16)
Milk (kg)	32.4	32.4	24.0
Concentrate (kg)	71.1	68.3	78.6
Hay (kg)	7.1	7.8	8.5
Total DM intake	110.6	108.5	111.1
DM intake calf/day	1.58	1.55	1.59

n = number of calves.

Calf Health and Dirtiness Score

Two calves from each treatment did not adapt to group feeding with cold milk and were removed from the study after 14 days. These calves could not compete at the group feeder and were losing body weight. There were little differences in the health parameters measured between treatments (Table 4). Individual new cases of calf diarrhoea were low across all treatments; however, the number of instances of group diarrhoea (all calves in a pen) were higher than expected. These outbreaks occurred during Weeks 2 to 4. Mortality rate was similar across treatments (5.8%). Incidences of colic (8%) were recorded shortly after feeding with all treatments.

TAD56 calves had lower dirtiness scores than either OAD56 or OAD42 for Week 2 ($P < 0.05$) and Week 4 ($P < 0.001$) (Table 5). OAD42 had the lowest score for Week 6 ($P < 0.05$). There were no differences in dirtiness scores between treatments for Weeks 1, 3, 5, 7, and 8.

DISCUSSION

The feeding of cold (room temperature) whole milk to calves either once or twice daily had no affect on calf daily live-weight gain when calves were fed as a group. Previous studies found no effect on calf

Table 3. Labour Input (sec/calf/day) Required Over 70 Days for Calves Offered Milk Either Twice Daily (TAD) and Weaned at 56 Days or Once Daily (OAD) and Weaned at Either 56 or 42 Days.

	Milk Transfer	Feed Milk & Clean Equipment	Feed Ration/Hay	Bedding/ Cleaning	Vet Time*	Total Time
TAD56 (n = 16)	35.0	22.4	16.6	12.6	1.1	88
OAD56 (n = 16)	18.0	16.8	18.6	11.9	1.0	66
OAD42 (n = 16)	13.2	14.0	14.8	10.2	0.8	53

n = number of calves.

*Additional time to daily milk feed time.

Table 4. Individual Calf Health Incidences and Instances of Diarrhoea Affecting a Pen of Calves Over 70 Days for Calves Offered Milk Either Twice Daily (TAD) and Weaned at 56 Days or Once Daily (OAD) and Weaned at Either 56 or 42 Days.

	Deaths	Calf Diarrhoea	Colic	Pneumonia	Group Diarrhoea
TAD56 (n = 16)	1	5	1	1	2
OAD56 (n = 16)	1	3	2	2	3
OAD42 (n = 16)	1	2	1	3	4

n = number of calves.

performance when calves were fed warm whole milk once or twice daily.[17] Similarly, no difference in calf performance was shown when calves were offered restricted quantities of milk replacer in 1 feed or 2 feeds daily.[5] Randall and Swannack[18] demonstrated no differences between once- or twice-daily feeding of cold milk substitute compared to feeding twice daily with warm substitute. Growth weight per calf in this current study (0.68 kg/calf/day) was similar to that demonstrated by Muir et al[19] (0.62 kg/day) with twice-a-day feeding and once-a-day feeding. OAD42 calves had similar live weight gain post weaning compared to OAD56 and TAD56 calves, which were offered milk for a further 2 weeks. This was probably due to the higher intake of concentrate post weaning due to earlier weaning off milk. Leaver and Yarrow[20] concluded that calves could be successfully weaned when eating 400 g concentrates per day. Jorgenson et al[3] also demonstrated higher post weaning intakes when calves were weaned at 3 weeks compared to at 5 or 7 weeks. Similarly, calf performance was not affected when calves were fed milk twice a day[3] or once a day[19] and weaned early at 5 weeks compared to calves weaned at 7 to 8 weeks. Frequency of milk feeding had no effect on the subsequent performance of calves from Day 70 to start of mating. The mean weight at mating was 352 kg/heifer, which would be considered a satisfactory target weight for Holstein Friesian heifers to achieve a high cyclicity rate at mating.[21]

Frequency of feeding had no affect on the consumption of concentrates or hay when calves were weaned at 56 days. This result is in agreement with the findings of Burt[13] who found no differences in the intake of solids when calves were fed milk once or twice daily. Burt[13] also suggested that once-a-day feeding could save considerable labour without affecting performance. In this present study, the lowest labour input per calf for total calf care was observed with OAD42. The reduction in labour input with this system was evident for the tasks of feeding, cleaning of feeding equipment, and transfer of milk to the calf house. This result is in agreement with the findings of a farm survey that showed some reductions in milk feeding time with once-a-day compared to twice-a-day feeding.[2] The daily labour input per calf recorded in this study was considerably lower than that reported previously for calves fed individually in hutches (8 to 10 minutes).[4,22] The lower labour input recorded was probably lower due to group feeding

Table 5. Dirtiness Scores (median [interquartile range]) of Calves Offered Milk Either Once Daily (OAD) and Weaned at Either 56 or 42 Days or Twice Daily (TAD) and Weaned at 56 Days.

Week	1	2	3	4	5	6	7	8
TAD56	8 (8-9)	8 (8-9)^{b}	9 (8-10)	8 (7-9)^{by}	8 (7-9)	9 (8-9)^{ab}	8 (7-9)	8 (7-8)
OAD56	9 (8-9)	9 (9-11)^{a}	9 (8-9)	9 (9-10)^{a}	9 (8-9)	9 (8-9)^{b}	8 (7-9)	8 (8-8)
OAD42	8 (7-8)	9 (9-10)^{a}	10 (9-11)	9 (8-10)^{a}	9 (8-9)	7 (7-8)^{a}	8 (8-10)	8 (7-9)
P value	NS	$P < 0.05$	$P = 0.058$	$P < 0.001$	$P = 0.06$	$P < 0.05$	NS	NS

n = number of calves.

$^{ab}P < 0.05$; $^{xy}P < 0.001$.

and the use of teat feeders. A higher number of incidences of group diarrhea occurred with the OAD systems; however, this did not result in differences in labour input time for veterinary attention between systems. This is mainly due to no individual calf attention required with group diarrhea and the substitution of milk feeding with that of electrolytes. More individual cases of diarrhoea requiring more individual attention were observed with the TAD56 system. Instances of group diarrhoea occurred during periods of very cold weather when both the calf house temperature and the temperature of the milk fed were low. Increased calf mortality and a refusal to drink milk during severe weather have previously been reported for calves offered cold milk.[18] The larger quantity of cold milk consumed at one feed with once-a-day feeding and low ambient temperature may explain the number of outbreaks of group diarrhoea that occurred with these treatments. While the cold environment may be expected to influence growth rates and feed efficiency, the feeding of cold milk to calves has been shown to increase concentrate intake and reduce milk intake[16] while not affecting calf performance.[8] However, feeding of cold milk (<10°C) to young calves (<3 weeks of age) when the calf house temperature is low (<10°C) may have welfare implications as higher numbers of group diarrhoea may be expected.

This study demonstrated that calves can be reared successfully using a once-a-day whole milk feeding system when calves are fed as a group and weaned from milk early (42 days) with reduced labour required for the once-a-day early-weaned group.

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