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Comparison of Two Conventional Restricted Daily Milk Allowance Methods in Dairy Calf Rearing with Respect to Growth and Behavioural Responses II. Behavioural Responses

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Abstract: This study was carried out to investigate the differences between two milk allowance methods based on 10% of birth weight or 10% of weekly adjusted live weight of dairy calves in respect to growth performance. Twenty Holstein Friesian calves (14 males, 6 females) were allocated into two different milk feeding schedules, one was based on 10% of birth weight (IBW, n = 10) and another was 10% of live weight which was determined on weekly basis (ABW, n = 10), for feeding whole milk during the rearing period. Each calf was monitored seven times in a day and these observations were made twice a week for a period of 1 h starting at 06.00, 08.00, 12.00, 14.00, 18.00, 20.00 and 22.00 h in 10 min intervals for determining behavioural responses. ABW showed less eating calf starter behaviour (9.66% vs 14.17%), eating hay behaviour (8.04% vs 11.62%), drinking water (2.07% vs 3.92%) and ruminating behaviour (15.55% vs 20.08%) than IBW calves ($p<0.01$). ABW calves showed the higher rate of lying (17.39% vs 13.20%), standing (15.31% vs 13.22%), restlessness (13.71% vs 6.18%) and licking contact (5.81% vs 2.09%) than IBW calves, except playing (12.46% vs 15.52%) ($p<0.01$). To conclude, weekly increased milk allowance decreased nutritional behaviours which may lead to delay in ruminal development, increased restlessness behaviour which susceptible to poorer welfare in dairy calves.

Key words: Restrict, milk allowances, calf rearing, nutritional and non nutritional behaviours

INTRODUCTION

Calves are fed twice a day with whole milk from buckets, typically an amount equivalent to 10% of their body weight daily (Appleby *et al*., 2001). This is the one of restricted-feeding programs differ markedly from the natural feeding behaviour of calves allowed to suckle their dam's or to consume milk ad libitum (Drackley, 2005). Intensively reared dairy calves are typically separated from the cow within 1-3 days of birth and fed restricted quantities of milk until weaning. The young calf has a strong motivation to suckle, which is not satiated by providing milk in buckets (Margerison *et al*., 2002). Various feeding and management practices on dairy farms can have profound impacts on overall mortality, morbidity and growth of the young calf. Successful calf growth and health depends on the combination of many factors related to health, management and nutrition of the neonate (Heinrichs *et al*., 1995).

Develop calf milk-feeding systems that are better adapted to the calf and develop management systems that ensure good productivity in calf rearing systems (de Passillé, 2001). When calves are supplied with milk in an open bucket, they can not suck and have to drink the milk. The calves on the lower milk allowance consumed more solid food before weaning and were thus better prepared for the weaning. Especially, when high allowances of milk are offered, it is important that the intake of solid foods is stimulated sufficiently before and when the calves are weaned to prevent the development of inter sucking (Jensen, 2003).

Several studies have assessed the impact of early rearing conditions on the subsequent behaviour of cattle. These studies have shown that confinement and artificial feeding systems all significantly influenced subsequent social behaviour, competitiveness and maternal behaviour. However, despite extensive investigation of different artificial rearing conditions in the literature, but little attention has been paid to behavioural responses of calves in early age as a response to different conventional milk allowance methods. The issue of behavioural responses of calves must also be addressed for artificially reared calves because this is central to animal welfare (Lauber *et al*., 2006). Since in most modern farms, the animals cannot perform many of the behaviours regularly seen in less restrictive environments. Animal welfare groups see such behavioural deprivation as a major problem with intensive animal husbandry, but in order to know whether behavioural deprivation reduces welfare (de Passillé, 2001).

This study examined the effects of two different milk allowance methods on the behavioural responses (nutritional and non-nutritional) of dairy calves.

MATERIALS AND METHODS

This study was conducted at Research Farm of Mustafa Kemal University in Hatay, Turkey. Hatay is located between 36 north latitude and 36 east longitude in the Eastern Mediterranean region. The experiment lasted 63 days including 3-day colostrum feeding. Twenty Holstein Friesian calves (14 males and 6 females) were used in this experiment. All calves were offered their dam's colostrums ad libitum for the first 3 days after birth via sucking. Then, these calves were separated from their mothers and allocated to be kept in individual pens where located in a semi-open barn. These pens sized 1.0 m×1.5 m were made from wooden. The calves were allocated to two different milk feeding schedules, one was based on 10% of birth weight (IBW, n = 10) and another was 10% of live weight which was on weekly basis (ABW, n = 10), for feeding whole milk during rearing period. When allocating calves to experimental groups, gender was equally distributed into experimental groups to eliminate the possible effects of gender on behavioral parameters.

All experimental pens were cleaned with water and furnished with new bedding material daily to serve calves hygienic housing conditions during experimental period. All experimental calves were allowed to drink whole milk (50/50 of whole milk) from plastic buckets with 5 L capacity in twice a day at the same time at 07.00 o'clock in the morning and 19.00 o'clock in the evening during 60 days. Calves were, simultaneously, offered calf starter, good quality alfalfa hay and water *ad libitum* after colostrum feeding. Calf starter included 220 g crude protein and 2.75 Mcal ME, 30 g crude fibre, 30 g crude oil, 70 g crude ash and 5 g yeast cultures containing 2.25×10 CFU *Saccharomyces cerevisiae* per kg.

Behavioural observations were recorded seven times in a day and these observations were made twice a week for a period of 1 h starting at 06.00, 08.00, 12.00, 14.00, 18.00, 20.00 and 22.00 h in 10 min intervals. Each calf was monitored to determine and record behavioural activity. The recorded activities were categorized as nutritional behaviours included eating calf starter, eating hay, rumination, drinking water and non nutritional behavours included lying, standing, restlessness, playing and licking contact. The descriptions of behavioural ethogram are given in Table 1. The method of behavioural observation was based on the methods of time sampling and point sampling (Fraser and Broom, 1990) with some modifications. Point was a calf in individual pen while scan was the first seen activity by observer. The data collection forms were prepared to record the incidence of behaviour elements in 10 min intervals during 1 h observation. The form included the identification of each calf in one column and the behavioural elements in one row for each time interval. When the observer scanned the individual calf, the first seen activity was marked on the data collection form for specific time intervals.

Behavioural data were analysed by Chi-square

Table 1: Description of behavioral elements observed during experimental period

Behaviours	Description of behaviours
Nutritional behaviours	
Eating calf starter	Chewing of calf starter
Eating hay	Chewing of alfalfa hay
Drinking water	Swallow water
Rumination	Ruminating when standing and lying position
Non-nutritional behaviours	
Lying	Lying without any movement or behaviour
Standing	Standing without any movement or behaviour
Restlessness	Butting and pushing on pen gates or walls, initiated with the sound of milk pails or by calf calls from neighbouring pen and forced into forward
Playing	Different body movements, jumping, body turning, buck kicking and head shaking
Licking contact	Licking of pen wall, feeding trough, milk bucket etc.

Table 2: The percentage count (%) of nutritional behaviours of calves subjected to different milk allowances for the period of 4-63 d

Hours	Groups	Eating calf starter	Eating Water	Drinking Hay	Rumination
06.00	ABW	7.070	5.030	2.190	9.210
	IBW	12.140	8.510	3.150	14.330
	S.E.D	0.870	0.910	0.830	1.270
	P-values	0.001	0.001	0.031	0.000
08.00	ABW	6.980	6.190	1.200	14.090
	IBW	13.560	10.030	2.840	18.110
	S.E.D	0.970	1.349	1.274	1.234
	P-values	0.001	0.000	0.001	0.001
12.00	ABW	12.680	11.120	3.340	16.220
	IBW	17.690	15.480	5.050	19.040
	S.E.D	0.972	1.008	0.609	1.025
	P-values	0.001	0.001	0.001	0.001
14.00	ABW	15.970	14.040	3.010	16.440
	IBW	20.160	17.030	5.960	20.350
	S.E.D	0.681	0.803	0.788	1.200
	P-values	0.001	0.001	0.001	0.001
18.00	ABW	11.620	9.780	2.070	12.340
	IBW	14.420	12.530	4.960	19.090
	S.E.D	0.847	0.662	0.092	1.118
	P-values	0.001	0.001	NS	0.000
20.00	ABW	5.550	4.170	1.460	19.180
	IBW	11.060	9.740	2.670	24.430
	S.E.D	0.651	2.113	0.082	1.003
	P-values	0.001	0.001	NS	0.001
22.00	ABW	7.780	5.930	1.210	21.420
	IBW	10.160	8.040	2.780	25.180
	S.E.D	0.701	0.963	0.641	1.367
	P-values	0.001	0.001	0.001	0.001
Pooled	ABW	9.660	8.040	2.070	15.550
	IBW	14.170	11.620	3.920	20.080
	S.E.D	1.087	2.111	1.022	2.217
	P-values	0.001	0.001	0.010	0.001

(Windows version of SPSS, release 13.00), based on frequency for 7 observation times (1st, 10th, 20th, 30th, 40, 50 and 60th min) for 1 h observation, the proportional count of behaviours were presented in Table 2 and 3, Fig. 1 and 2.

RESULTS

The experimental results regarding nutritional behaviours (eating calf starter, eating hay, drinking water and rumination) and non-nutritional behaviours (lying, standing, restlessness, playing and licking contact) by experimental groups are presented Table 2 and 3, Fig. 1 and 2.

Nutritional behaviours

Eating calf starter: According to Table 2, IBW calves showed more eating calf starter behaviours than ABW calves (14.17% vs 9.66% during the 4-63 d ($p<0.01$). IBW calves showed the highest rate of eating calf starter at 14.00 p.m ABW calves decreased eating calf starter by 1.27% after milk feeding time at 07.00 a.m in the morning while IBW calves increased calf starter intake by 11.70% after milk drinking, compared to the determined behaviours at 06.00 am. After evening milk feeding, eating calf starter behaviour was seen in ABW calves in lower rate compared to that of IBW calves. Decreases in these rates were as 52.24 and 23.30% in IBW calves ate higher amount of calf starter in the period of 4-33 d while ABW calves increased calf starter intake after 34 d. During the experimental period (34-63 d) ABW and IBW calves increased starter intake behaviour about 106.25 and 23.15% (Fig. 1), respectively.

Table 3: The percentage count (%) of non-nutritional behaviours of calves subjected to different milk allowances for the period of 4-63 d

Times	Groups	Lying	Standing	Restlessness	Playing	Licking contact
06.00	ABW	6.59	22.30	28.100	10.550	8.96
	IBW	8.97	17.030	15.700	17.060	3.11
	S.E.D	1.200	1.600	1.230	2.010	2.660
	P-values	0.001	0.001	0.000	0.000	0.000
08.00	ABW	22.630	12.980	12.330	18.310	5.290
	IBW	7.080	16.560	8.410	21.040	2.370
	S.E.D	0.765	1.741	1.659	1.336	1.264
	P-values	0.000	0.001	0.001	0.001	0.001
12.00	ABW	14.000	10.560	13.480	12.560	6.040
	IBW	13.370	8.970	3.560	14.520	2.320
	S.E.D	0.103	0.789	2.103	0.681	1.907
	P-values	NS	0.001	0.001	0.001	0.001
14.00	ABW	19.180	8.710	7.870	9.810	4.970
	IBW	15.640	6.490	1.730	11.280	1.360
	S.E.D	0.904	0.652	3.283	0.875	2.103
	P-values	0.001	0.001	0.000	0.001	0.000
18.00	ABW	10.570	22.430	19.310	7.870	4.010
	IBW	11.050	17.810	9.920	7.610	2.610
	S.E.D	0.124	1.943	1.365	0.291	0.304
	P-values	NS	0.000	0.001	NS	0.046
20.00	ABW	24.630	14.710	10.620	13.230	6.450
	IBW	16.240	14.080	2.850	17.090	1.840
	S.E.D	1.289	0.107	2.452	0.987	3.113
	P-values	0.001	NS	0.000	0.001	0.000
22.00	ABW	24.160	15.460	4.240	14.870	4.930
	IBW	20.070	11.620	1.090	20.060	1.000
	S.E.D	1.007	0.709	1.406	1.104	2.108
	P-values	0.001	0.001	0.000	0.001	0.000
Pooled	ABW	17.390	15.310	13.710	12.460	5.810
	IBW	13.200	13.220	6.180	15.520	2.090
	S.E.D	1.305	2.213	2.981	1.129	2.406
	P-values	0.001	0.001	0.001	0.001	0.010

Eating hay: IBW calves showed higher eating hay behaviour than ABW calves (11.62% vs 8.04% during the experimental period ($p<0.01$, Table 2). The highest eating hay was seen at 14.00 pm. in IBW calves. Both ABW and IBW calves increased eating hay behaviour in comparison to the observation time at 06.00 am before morning milk feeding time. These increases were as 23.06 and 17.86% in ABW and IBW calves, respectively.

After evening milking time, ABW calves decreased eating hay behaviour about 57.36% compared to before evening milking time while this was just about 22.27% in IBW calves. Both ABW and IBW calves increased hay intake behaviour during the period of 34-63 d. These increase rates were 26.47% in ABW and 15.99% in IBW calves (Fig. 1).

Drinking water: IBW calves showed more drinking water behaviour (2.07%) than ABW calves (3.92%) during the 4-63 d ($p<0.01$, Fig. 1). During the 34-63 d ABW and IBW calves increased drinking water behaviour about 53.99 and 50.48%, respectively.

Rumination: IBW calves showed more rumination behaviour than ABW calves (20.08% vs 15.56% during the experimental period ($p<0.01$). IBW calves ruminated the highest rate at 22.00 pm. (Table 2). Both ABW and IBW calves increased rumination behaviour during the 34-63 d about 86.90 and 28.95%, respectively.

Non-nutritional behaviours

Lying: ABW calves showed 17.39% lying behaviour while IBW calves did 13.20% during the 4-63 d ($p<0.01$, Table 3). ABW calves increased lying behaviour about 243.39 and 133.02% after morning and evening milk feeding time but these were seen in IBW calves as 21.07%

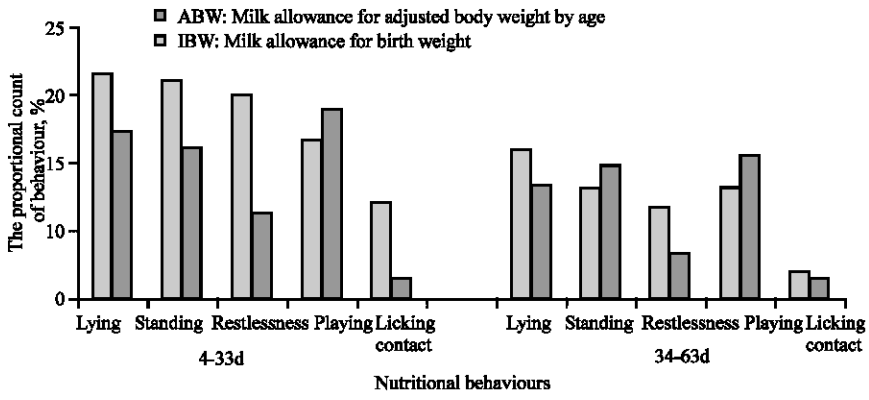

Fig. 1: Nutritional behaviours calves subjected to different milk allowances

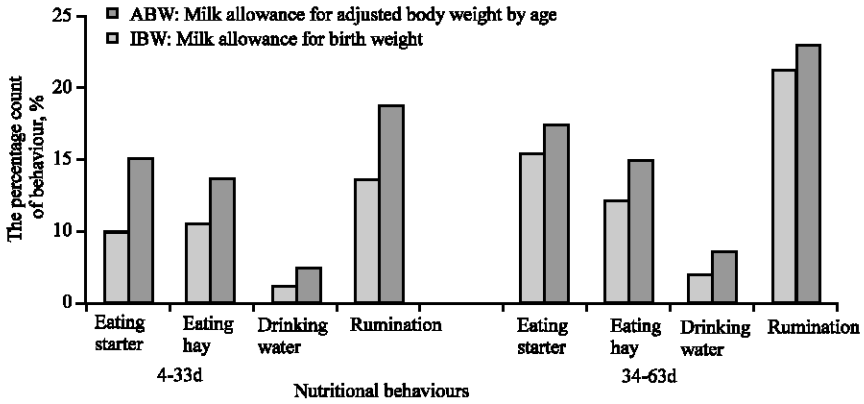

Fig. 2: Non-nutritional behaviours calves subjected to different milk allowances

decrease after morning milk feeding time and 46.97% increase in evening milk feeding time. During the period of 34-63 d, both ABW and IBW decreased lying behaviour about 33.99 and 30.17%, respectively (Fig. 2).

Standing: ABW calves showed 15.31% standing behaviour while IBW calves did 13.22% ($p<0.01$, Table 3). ABW and IBW calves decreased standing behaviour about 41.79 and 2.76% after morning milk feeding time (08.00 am.) and 34.42 and 20.94% after evening milk feeding compared to previous observation times. During the period of 34-63 d, ABW calves decreased standing behaviour about 48.94% while IBW calves decreased this behaviour about 11.41% (Fig. 2).

Restlessness: Restlessness in ABW calves was higher than that of IBW calves (13.71% vs 6.18%) during the 4-63 d ($p<0.01$). This behaviour was the highest at 6.00 am. in ABW calves. Restlessness behaviour decreased morning and evening milk feeding time about 56.12 and 45% in ABW calves, 46.43 and 71.27% in IBW calves (Table 3). During the period of 34-63 d, ABW calves decreased restlessness behaviour about 54.77% but IBW calves decreased this behaviour more than ABW calves about 47.60% (Fig. 2).

Playing: ABW calves showed 12.46% playing behaviour while IBW calves did 15.52% during the experimental period ($p<0.01$). Playing behaviour increased after morning and evening milk feeding time about 73.55 and 68.11% in ABW calves, about 23.33 and 124.57% in IBW calves (Table 3). Both treatment calves decreased playing behaviour during the period of 34-63 d, as decreased 29.32 and 23.94% (Fig. 2).

Licking contact: ABW calves showed more licking contact than IBW calves during the 4-63 d (5.81% vs 2.09%, $p<0.01$). This was the highest in ABW calves at 06.00 a.m. (Table 3). During the period of 34-63 d, ABW calves decreased licking contact behaviour about 72.44%

while IBW calves decreased this about 2.83% (Fig. 2).

DISCUSSION

Nutritional behaviours: IBW calves showed higher percentage of eating behaviour than ABW calves since ABW calves whose milk allowance were modified weekly drunk higher amount of milk compared to IBW calves while IBW calves drunk a fixed amount of milk during all experimental period. These IBW calves most likely try to compensate their nutritional requirements by consuming more calf starter and hay. When calves allowed drink more milk, their food intake decrease consequently (Fiems *et al*., 1982; Bøe and Havrevoll, 1988; Hepola, 2003). However, ABW calves did not delay growth in the present experiment. Perhaps, ruminal development of ABW calves was delayed by drinking more milk compared to IBW calves.

IBW calves showed more drinking water behaviour compared to ABW calves. This can be explained higher consumption of dry matter intake and lower liquid (milk) allowance in IBW calves.

IBW calves showed more ruminating behaviour than ABW calves because they consumed higher amount of calf starter and hay than the latter calves.

Non-nutritional behaviours: ABW calves showed more lying behaviour, especially after milk allowance in the morning and evening during the period of 4-33 d. This can be explained as ABW calves consumed sufficient amount of milk by adjusting milk allowance weekly. During the period of 34-63 d, both ABW and IBW calves decreased lying behaviour while increased eating behaviours to compensate their nutritional requirements which increased by age.

During experimental period ABW calves showed a higher rate of standing behaviour than IBW calves. ABW calves showed more restlessness and less playing behaviour. During the period of 34-63 d, ABW calves decreased standing behaviour because they started to eat calf starter and hay after 34-d.

IBW showed more playing behaviour than ABW calves. IBW calves started to eat calf starter and hay earlier than ABW calves. This may lead more playing activity in IBW calves, showing they were in well being condition. Sufficient milk intake is essential for the expression of play behaviour in domestic calves. Play is generally regarded as a positive indicator of health and well-being condition and play may have several developmental benefits for the animal (Spinka *et al*., 2001). ABW calves showed higher rate of licking contact by contacting their tongue tools and feeders when they were hunger, since they consumed higher amount milk and lesser amount of calf starter and hay compared to IBW calves. Before milk allowance in the morning and evening, ABW calves showed higher rate of licking contact behaviour, supporting this approach.

The initial licking contact activity may be attributed to inadequate stimuli or coping with the frustration by licking alternative objects to drinking milk. The decline thereafter was most likely replaced by an increase in solid feed consumption and rumination, occupying a significant proportion of its time (Babu *et al*., 2004).

Play in calves was noticed in the form of locomotor play like sounding, jumping, buck kicking and different body movements. The significant activity in IBW group calves was thus an indication of beter welfare. Lawrence (1987) reported that play is a good indicator of animal welfare in captive animals. Less opportunity for milk feeding did not facilitate for play by the calf. This also forced the calf to stand idle compared to IBW groups ones. An increased lying time in ABW groups calves may be cumulative to all above factors. Additionally, the negative influence on time spent in eating activity and above all, a decrease DM consumption in ABW calves may be accredited to less opportunity of learning through socialisation as that observed in IBW calves.

Restlessness is a combination of different activities like frequent mounts, butting and pushing on pen gates or walls, initiated with the sound of milk pails or by calf calls from neighbouring pen. Increased restlessness during pre-milk feeding hours may be suggestive of calf's ingestive drive for feed. Comparatively more activity in the morning may be attributed to long intervals from evening to next morning feeding time (Babu *et al*., 2004).

CONCLUSION

The present study showed that IBW calves were showed more eating activity and less restlessness behaviour, suggesting that milk should be allowed by the criterion of 10% of birth weight rather than 10% of the changed body weight by age.

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