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Comparison of Two Conventional Restricted Daily Milk Allowance Methods in Dairy Calf Rearing with Respect to Growth and Behavioural Responses 1. Growth Responses

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Abstract: This study was carried out to investigate the differences between two milk feeding methods (allowances) 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. All calves were kept in individual pens located in a semi-open barn for 60 days. Feed intake, live weight, body length, withers height, heart girth, chest depth and rump height and width measurements of calves were determined for both groups. Daily calf starter intake were 490 vs 640 g ($p<0.01$), daily hay intake 150 vs 220 g ($p<0.01$), daily total feed intake 640 vs 860 g ($p<0.01$), daily milk allowance 5.06 vs 3.24 kg ($p<0.01$), daily live weight gain 530 vs 515 g ($p>0.05$), daily body length gain 0.213 vs 0.219 cm ($p>0.05$), daily withers height gain 0.176 vs 0.164 cm ($p>0.05$), daily heart girth gain 0.288 vs 0.280 cm ($p>0.05$), daily chest depth gain 0.119 vs 0.114 cm ($p>0.05$), daily rump height gain 0.163 vs 0.154 cm ($p>0.05$) and rump width gain 0.069 vs 0.062 cm ($p>0.05$) were determined in ABW and IBW calves respectively. Starting time of calf starter intake, hay intake and rumination were 12 vs 9 days ($p<0.01$), 13 vs 11 days ($p<0.01$) and 14 vs 11 days ($p<0.01$) for ABW and IBW calves respectively. In conclusion, milk allowance during calf rearing by criterion of 10% of birth live weight basis encouraged calves better than that of 10% of adjusted live weight basis to compensate their increased nutritional requirements by consuming other foods calf starter and alfalfa hay.

Key words: Restrict, milk allowances, calf rearing, growth, body measurements

INTRODUCTION

Raising calves is one of the most important aspects of dairy herd management because of the cost of milk and calf rearing. The calf-raising program is, also important as a means of replacing animals that leave the herd each year through involuntary culling (Schmidt and Van Vleck, 1974). In calf rearing, there have been applied many milk feeding programs. These programs usually vary according to the changes in the price of milk for market. Conventionally, 80-600 kg milk is used for calf with having a grate variation affected by many factors such as milk price, knowledge of calf rearing and milk production systems (Yanar *et al*., 1996). Conventional calf-rearing systems typically restrict the amount of milk or milk replacer fed during the first few weeks of life in an effort to encourage solid fed intake and allow early weaning (Drackley, 2005). Since volatile fatty acids (particularly butyrate) from the fermentation of concentrate-based ingredients are the stimulus for development of the ruminal epithelium, early consumption of starter Dry Matter (DM) is important for systems in which the goal is early weaning and the lowest cost rearing program (Davis and Drackley, 1998). In order to propagate starter consumption, calves are typically fed restricted quantities of milk about 10% of body weight per day (Thomas *et al*., 2001). Not surprisingly, the restricted-fed calves gain much less weight than calves allowed suckling the cow (Flower and Weary, 2001). However, the latter allowance is not applicable for dairy herd management. If it is possible, it can cause digestive upsets and scouring, appetite loss, thus prolonging weaning time (Amaral-Phillips *et al*., 2001). One common practice is to provide calves with milk twice a day, for a total of approximately 10% of the calf's body weight, such that a 40 kg calf would receive two meals each of approximately 2 kg (Jasper and Weary, 2002). However, there is a question whether the determination of body weight is made weekly until weaning time or not, i.e., only based on birth live weight for all calf rearing period until weaning time. Consequently, there will be choice for calf rearing to be decided according to calf's growth physiology and milk price. Therefore, the current study was conducted to determine the growth performance of calves subjected to two different milk allowances 10% of birth weight and 10% of the increased live weight during weaning period.

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 close to each other in a semi-open barn. These pens sized 1.0×1.5 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 effects of gender on determined growth parameters. Birth weights of calves were taken as co-variant factor.

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 2.25×10^9 CFU *Saccharomyces cerevisiae* per kg.

For growth parameters such as, live weight, body length, withers and rump height, heart girth and feed intakes were determined the same time weekly. Body size measurements were taken by using measuring tape and stick. The body weights were determined by using electronic scale with 100 g sensitivity. The calves were measured and weighed by the same person during the experimental period. The calves were placed on a flat surface during the body size measuring and placed in a cart that restrained movement, the cart was placed on a platform electronic scale. Also, the first time of eating calf starter, alfalfa hay and rumination activity were recorded.

To distinguish the difference between two housing systems, the data concerning body weights, body size, feed intake and body measurements were analysed by using GLM with Repeated Measure (SPSS for Windows, release 13.00).

RESULTS

The experimental results regarding feed intake results are shown in Table 1 and Fig. 1 while results regarding birth weight, live weight and daily live weight gain and body measurement parameters by experimental groups are shown in Table 2 and Fig. 2.

IBW calves consumed higher amount of calf starter compared to ABW calves IBW calves consumed daily 210 and 1493 g calf starter at third and ninth week of rearing group respectively while ABW calves consumed less amount of daily calf starter, i.e., 140 and 1107 g on these periods ($p<0.01$). On the same way, IBW calves ate more alfalfa hay about 4.2 kg per calf for rearing compared to ABW calves ($p<0.01$). On the contrary, ABW calves drunk 115 kg higher amount of whole milk compared to IBW calves during the 0-63 d ($p<0.01$).

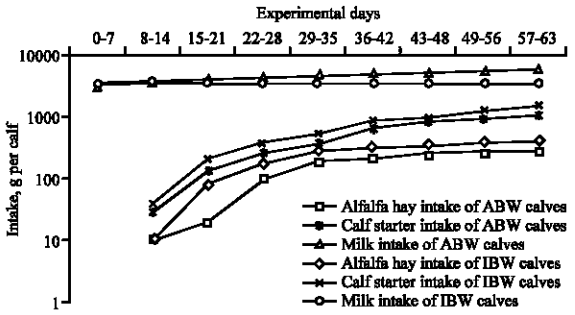

Fig. 1: Feed and milk intakes of experimental calves

Table 1: The effects of different milk-fed Schedule on feed intake dairy calves pre-weaning period (4-63d)

Parameters, calf	ABW Calves	IBW Calves	SED	P
Daily calf starter intake				
Wk 3, g	140	210	0.26	0.036
Wk 4, g	270	390	0.24	0.000
Wk 6, g	670	850	0.27	0.000
Wk 9, g	1107	1493	0.31	0.000
Total intake (0-63 d), kg	30.91	40.40	2.420	0.001
Daily intake(0-63 d), g	490	640	0.038	0.001
Daily hay intake				
Wk 3, g	20	80	0.33	0.000
Wk 4, g	100	180	0.39	0.002
Wk 6, g	220	330	0.41	0.014
Wk 9, g	290	380	0.44	0.000
Total intake (0-63 d), kg	9.50	13.70	1.748	0.001
Daily intake(0-63 d), g	150	220	0.024	0.001
Total feed intake				
Wk 3, g	160	290	0.206	0.002
Wk 4, g	370	570	0.379	0.003
Wk 6, g	890	1175	0.341	0.116
Wk 9, g	1400	1870	0.390	0.003
Total intake (0-63 d), kg	40.40	54.10	3.168	0.003
Daily intake(0-63 d), g	640	860	0.058	0.003
Milk intake				
Total milk intake (0-63 d), kg	319	204	10.454	0.000
Daily milk intake (0-63 d), kg	5.06	3.24	0.166	0.000
Other parameters				
Starting to rumination activity, d	14	11	0.549	0.003
Starting to hay intake, d	13	11	0.471	0.002
Starting to calf starter intake, d	12	9	0.326	0.000

Table 2: The effects of different milk-fed programme on dairy calves growth performance

Parameters, calf:	Ages	ABW calves	IBW calves	SED	P
Body weight, kg	birth	32.45	34.06	0.783	0.634
	Wk 2	39.50	37.64	0.806	0.974
	Wk 4	46.34	43.61	1.639	0.069
	Wk 6	52.57	49.46	1.798	0.142
	Wk 9	65.86	66.50	0.818	0.745
	Daily gain (0-63 d)	0.530	0.515	0.113	0.802
Withers height, cm	birth	71.44	70.94	0.269	0.368
	Wk 2	73.28	73.39	0.316	0.866
	Wk 4	75.06	75.89	0.304	0.177
	Wk 6	77.61	77.94	0.341	0.640
	Wk 9	82.55	81.89	0.417	0.480
	Daily gain (0-63 d)	0.176	0.164	0.066	0.905
Body length, cm	birth	67.72	68.22	0.866	0.645
	Wk 2	71.00	71.28	0.433	0.707
	Wk 4	73.61	73.94	0.600	0.642
	Wk 6	76.39	76.50	0.551	0.881
	Wk 9	81.18	82.07	0.501	0.519
	Daily gain (0-63 d)	0.213	0.219	0.069	0.896
Chest depth, cm	birth	27.94	27.50	0.263	0.414
	Wk 2	29.83	29.78	0.211	0.900
	Wk 4	31.50	31.50	0.265	1.000
	Wk 6	32.78	32.56	0.346	0.767
	Wk 9	35.44	34.69	0.327	0.261
	Daily gain (0-63 d)	0.119	0.114	0.117	0.163
Heart girth, cm	birth	72.61	71.19	1,348	0.496
	Wk 2	75.67	74.38	0.920	0.430
	Wk 4	79.22	78.44	0.979	0.261
	Wk 6	83.28	82.56	1.118	0.200
	Wk 9	90.73	88.85	1.244	0.119
	Daily gain (0-63 d)	0.288	0.280	0.116	0.105
Rump height, cm	birth	75.50	74.88	0.642	0.642
	Wk 2	77.56	77.69	0.555	0.910
	Wk 4	79.83	79.56	0.493	0.794
	Wk 6	81.94	81.38	0.481	0.572
	Wk 9	85.78	84.56	0.660	0.375
	Daily gain (0-63 d)	0.163	0.154	0.090	0.768
Rump width, cm	birth	21.11	21.50	2.008	0.328
	Wk 2	22.33	22.81	2.002	0.234
	Wk 4	23.06	23.63	2.020	0.042
	Wk 6	23.72	24.25	2.061	0.095
	Wk 9	25.44	25.38	2.164	0.826
	Daily gain (0-63 d)	0.069	0.062	0.039	0.485

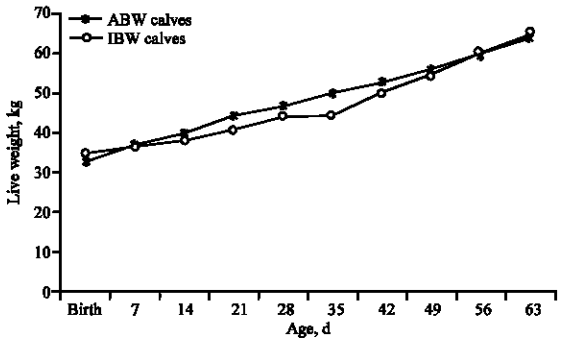

Fig. 2: Live weight changes of BW and LW calves

With respect to ruminal function by time, IBW calves started earlier to consume calf starter (9 vs 12 days), alfalfa hay (11 vs 13 days) and consequently rumination (11 vs 14 days) than those of ABW calves during the experimental period ($p<0.01$).

Even though IBW calves were heavier than ABW calves about 1.61 kg at the beginning of study, ABW calves gained more rapid during the period of 4-33-d compared to IBW calves. This was more visible on live weights of calves at 28 d old that ABW calves were 2.73 kg heavier than IBW calves ($p<0.05$, Table 2). However, this live weight gain in ABW calves decreased after 28-d in comparison to IBW calves whose live weight gain started to increase afterwards (Table 2 and Fig. 2).

According to Table 2 and Fig. 2, IBW calves showed better performance without any statistical significance ($p>0.05$). At the end of experiment all calves were similar with respect to their body measurements such as body length, withers height, chest dept, hearth girth, rump height and rump width ($p>0.05$).

DISCUSSION

This study was conducted to compare whole milk feeding schedules based on initial birth live weight and weekly body weight with respect to growth performance of dairy calves. These milk feeding schedules are both applicable in practice depending on milk price. However, physiological consequences of these methods needed to be compared and there have been a limited source on literature in a comparative manner.

In early age until 28-d old, ABW calves gained more rapidly (about 2.73 kg higher) than IBW calves although the latter calves were 1.61 kg heavier than the former calves at the beginning of study. This can be explained that the main nutritional source, of course, is "milk" for baby calves and ABW calves tasted this opportunity to have whole milk during the period of 4-28 d when ABW calves' milk allowance increased three times, 10% of measured live weight at 7-d, 14-d and 21-d. Also, their rumen had not been functional during this period yet to digest and utilise calf starter and alfalfa hay properly. Because of this, they did not consume calf starter and alfalfa hay as much as IBW calves did. IBW calves had to drink lesser amount milk, only 10% of birth weight, than ABW calves. However, after 28-d old, the increase in live weight gain in ABW calves started to decrease. This can be explained that ABW calves did not consume enough calf starter and hay as IBW calves did and, consequently, their rumen and other digestive compartments, most likely, might have not developed enough because of weekly increased milk drinking and deficiency in volatile fatty acid production for being stimulants for ruminal development. Their increased nutritional requirements by age were not compensated any more by only milk drinking. Also, ABW calves started to consume calf starter and alfalfa hay later compared to IBW calves.

On the contrary, IBW calves drunk limited milk 10% of birth weight all the time and there had been an increased their nutritional gaps by age or day to day. Most likely, this forced IBW calves to start to consume calf starter and hay in order compensate their nutritional requirements. This can be evidenced by calf starter and alfalfa hay intakes of both ABW and IBW calves in Table 1. Also, previous studies supported this approach. When calves drink *ad libitum,* they usually eat less concentrates, leading slow growth (Fiems *et al*., 1982; Bøe and Havrevoll, 1988). Calf starter ration will stimulate early rumen function and establishment of the rumen microbial population and growth of the rumen papillae. Calf starter is more effective than hay in encouraging rumen development. Early rumen development allows early weaning and helps the calf overcome stresses associated with the milk feeding period. However, solely milk feeding decreased rumen papilla and absorptive structures while calf starter helped rumen development (Roy, 1980).

In the current study, ABW calves were allowed to consume milk depending on their increased live weight. This caused in ABW calves less consumption of calf starter and hay. Jasper and Weary (2002) allowed calves to have whole milk ad lib and their calves drank 89% more milk than calves fed conventionally during the pre-weaning period, but these calves ate only 16% as much calf starter and 17% as much hay those of conventional fed calves without affecting growth

The results of current study show that IBW calves tried to compensate their nutritional requirements by earlier start of calf starter and hay consumption in comparison to ABW calves. For overall experimental period, ABW calves consumed about 9.5 kg less calf starter and 4.2 kg less alfalfa hay compared to IBW calves ($p<0.001$) since ABW calves started to consume hay 2 days later, to calf starter 3 days later and, consequently, to ruminate 3 days later than IBW calves. On the other hand, IBW calves were allowed to drink whole milk about 115 kg lesser than that of ABW calves, but both IBW and ABW calves were similar with respect to final body weight and body size (Table 2). This shows that IBW calves have the ability to compensate their nutritional requirements by evaluating other food opportunities. Calves have the ability to do so, ie., to catch genetically determined live weight gain, as Von Keyserlingk *et al.* (2006) determined that 4-h milk fed calves compensated by changing their milk feeding behaviour and are able to achieve similar weight gains to animals fed milk continuously.

Current conventional systems during the milk feeding period in an effort to encourage early intake of calf starter, allow earlier weaning and decrease costs of heifer rearing (Drackley, 2005).

In the current study, IBW feeding milk schedule served this approach better than ABW feeding milk schedule. This approach also showed that weaning age can be decreased to 6 weeks old in IBW calves since they consume daily 0.85 kg calf starter which was more than 1.5% of their live weights (about 50 kg live weight at 6 wk) to be advantage of restricted milk feeding and the quantity of saleable. Greenwood *et al.* (1997) used dry feed intake rate as a percentage of initial body weight as a weaning criterion to reduce variation in weaning age. According to these researches, setting dry feed intake at 1% of initial body weight rather than at 1.5 or 2% reduced the number of days to weaning, increased dry feed intake post weaning to 8 week and had no apparent negative effect on body weight gain. Also, they suggested additional work needed to be done to investigate the economical and metabolic implications of using dry feed intake rate as a percentage of initial body weight and to establish the optimum dry feed intake rate. Finally, the growth data of current study and the work of IBW calves to compensate their nutritional requirements by consuming calf starter and hay at least supported the approach of Greenwood *et al.* (1997) on weaning time as Appleman and Owen (1975) reported that the predetermined dry feed intake used to establish the weaning of dairy calves ranged from 0.45 to 0.91 kg per day.

When making some calculation (115 kg milk difference between ABW and IBW calves: 9.5 kg calf starter intake difference between ABW and IBW calves = 12.10) on current milk intake and calf starter intake, it can be estimated that every 1 kg calf starter intake may allow 12 kg additional milk for sale, with positive economic returns in most price conditions. Of course, 9.5 kg calf starter is cheaper than 115 kg whole milk.

Routine veterinary check-up during experimental period showed that all calves were healthy and there were no incidence of any illness and mortality for both ABW and IBW calves.

CONCLUSION

Milk allowance during calf rearing by criterion of 10% of birth live weight encouraged calves better to compensate their increased nutritional requirements by consuming other foods calf starter and hay in comparison to calves allowed whole milk by criterion of 10% of weekly increased live weight.

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