Turk J Vet Anim Sci
30 (2006) 235-241

Research Article

Effects of Feeding Acidified Milk Replacer on the Growth, Health and Behavioural Characteristics of Holstein Friesian Calves

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Received: 11.07.2005

Abstract: The objective of this study was to compare the performances of calves fed acidified milk replacer (AMR) or sweet (regular) milk replacer (SMR) at 8% of birth weight. Twenty-one calves (10 males, 11 females) were offered replacers reconstituted to 12% of dry matter over 5 weeks. In the group fed AMR, daily body weight gains of calves at the different stages of growth were comparable to those for calves fed SMR. In the preweaning period, calves offered AMR had similar dry matter intakes from starter, milk replacer and dry hay as well as total intake as those fed SMR. In the postweaning phase, total dry matter intakes of calves offered AMR and SMR were not statistically different. The overall feed efficiency ratios of AMR-fed calves were better ($P < 0.05$) than those of SMR-fed calves. Calf faecal consistency score ($P < 0.05$) and percent days with scours ($P < 0.01$) of calves offered AMR were significantly lower than those fed SMR for days 4 to 17. AMR-fed calves needed a longer time ($P < 0.01$) to consume the daily amount of replacer than SMR-fed calves. The calves fed AMR also took a significantly ($P < 0.05$) greater number of days to learn to drink milk replacer from an open pail without help than calves consuming SMR. In conclusion, it is suggested that the growth performance and feed efficiency characteristics of calves reared under the new feeding system with AMR were not adversely affected, but the incidence of scours of the young calves was dramatically reduced.

Key Words: Acidified milk replacer, calf feeding, weight gain, scours, calf behaviour

Ekşitilmiş Süt İkame Yemi ile Beslemenin Siyah Alaca Buzağıların Büyüme, Sağlık ve Davranış Özellikleri Üzerine Etkileri

Özet: Bu çalışmada, doğum ağırlığının % 8'i düzeyinde ekşitilmiş (ESİY) veya normal (tatlı) süt ikame yemi (NSİY) ile beslenen buzağıların performansları karşılaştırılmıştır. Beş hafta süre ile, % 12 kuru madde olacak şekilde hazırlanan süt ikame yemleri, toplam 21 buzağıya (10 erkek ve 11 dişi) içirilmiştir. ESİY tüketen buzağılarda büyümenin farklı evrelerinde sağlanan günlük canlı ağırlık artışları NSİY alan buzağılarla benzer şekilde olmuştur. Sütten kesim öncesi dönemde ESİY ile beslenen buzağılar süt ikame yemi, starter yem ve kuru ottan elde ettikleri kuru madde ile toplam kuru madde tüketimleri açısından NSİY ile beslenen buzağılarla benzer sonuçlar göstermiştir. Sütten kesim sonrası dönemde, ESİY ve NSİY alan buzağılarda toplam kuru madde tüketimleri istatistiksel olarak önemli derecede farklı bulunmamıştır. ESİY ile yemlenen buzağılarda genel yemden yararlanma değerinin NSİY ile beslenenlerden daha iyi ($P < 0,05$) olduğu belirlenmiştir. ESİY verilen buzağılarda 4-17. günler arasında dışkı kıvam puanının ($P < 0,05$) ve ishalli geçen günlerin oranının ($P < 0,01$) NSİY tüketenlere göre önemli derecede düşük olduğu bulunmuştur. ESİY ile beslenen buzağılar, NSİY alanlara göre günlük süt ikame yemlerini daha uzun ($P < 0,01$) bir sürede tüketmişlerdir. ESİY ile beslenen buzağılar NSİY tüketenlere göre açık kovadan herhangi bir yardım almaksızın süt ikame yemini içmeyi öğrenmek için çok daha fazla ($P < 0,05$) güne ihtiyaç duymuşlardır. Sonuç olarak, ESİY kullanılarak yeni geliştirilen buzağı besleme programının büyüme ve yemden yararlanma özellikleri üzerine olumsuz bir etkisinin olmadığı, ancak, genç buzağılarda ishal görülme sıklığını çok önemli miktarlarda azalttığı söylenebilir.

Anahtar Sözcükler: Ekşitilmiş süt ikame yemi, buzağı yemlemesi, ağırlık artışı, ishal, buzağı davranışı

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Introduction

Dairy calves have been reared under many different management schemes. Researchers strive to develop new feeding methods that save labour, promote improved growth performance, and are simple and cost effective. For this purpose, a new dairy calf-rearing programme was developed and tested by Yanar et al. (1), and Yanar et al. (2). Although their results revealed that whole milk could be replaced by milk replacer without a detrimental effect on the growth parameters of young animals, the occurrence of diarrhoea among the calves was moderately high, especially during the first weeks of life.

Acidification of milk replacer for use in rearing calves has been studied by several investigators (3-6). The benefits of feeding acidified milk replacer (AMR) include preservation of milk replacer for up to 3 days, prevention of rapid growth of pathogenic organisms in digestive tract, and reduce incidence of infectious scours in calves 3 weeks of age and less (7-9).

The study was undertaken to compare the incidence of diarrhoea, growth and feed intake characteristics as well as behavioural traits of Holstein Friesian calves fed sweet milk replacer (SMR) or AMR under a new calf feeding system.

Materials and Methods

Twenty-one Holstein Friesian calves (10 males and 11 females) from the cattle herd of the Research Farm of the Agricultural Faculty at Atatürk University were used. The calves were allowed to nurse to receive colostrum for 3 days after birth, and were assigned randomly at 3 days of age to 1 of 2 dietary treatments (SMR or AMR groups) according to gender. Then they were housed in a calf barn containing individual hutches with feeders and a milk-water bucket. The hutches were bedded with straw. The experiment lasted for 6 months.

The calves received either SMR or AMR from open pails once a day (8.30 AM) at 8% of their birth weight. The amount of replacer was kept constant before weaning at 5 weeks of age. The replacer was reconstituted to 12% dry matter as recommended by the manufacturer. Milk replacer was mixed fresh every day and half of the replacer was acidified by the addition of the formic acid. The pH value of the AMR was 4.8.

Two different calf starters were used in this study. Starter I was given from birth to 4 months of age and starter II was available after 4 months of age. The daily amount of starter offered to calves was limited to 2 kg/head, but the calves were fed dry hay ad libitum during the experiment. Chemical compositions of the feeds used in this study are tabulated in Table 1.

Individual body weights were recorded at birth, weaning, and 4 and 6 months of age. Body measurements such as body length, height at withers, heart girth and chest depth were taken at birth and 6 months of ages. Daily feed intake including milk replacer, calf starters and hay were also recorded for each calf.

Fecal consistency scores for calves were determined daily as follows: 1 = normal (soft-solid consistency, no fluid), 2 = soft (semi-solid, mostly solid), 3 = runny (semi-solid, mostly fluid), 4 = watery (all fluid), as described by Larson et al. (10).

Behavioural data were obtained from individual video records of each calf at 5 min interval. The data were collected from day 4 to 35, and video records were made after serving the milk replacer to the calves every morning. The data included: 1) total time spent for the intake of milk replacers, 2) time spent licking the walls of the pen, 3) time spent looking around, 4) number of days needed to teach the calf how to drink milk replacer from an open pail without help, 5) frequency of the daily milk replacer intake from the open pail.

Table 1. Chemical composition of milk replacer, starter rations and dry hay.

Nutrients	Milk replacer #	Starter I (%)	Starter II (%)	Dry hay (%)
Dry Matter	96.5	90.0	89.0	90.5
Protein	20.0	18.0	17.0	5.1
Ether extract	14.0	3.0	3.1	2.2
Ash	10.0	7.1	7.4	9.6
Cellulose	1.0	9.0	10.4	27.6

Composition of the milk replacer in the meal form.

The data were analysed statistically using a 2 x 2 completely randomised factorial experimental design. Birth weight was included in the statistical model as a covariate, when growth and feed parameters were analysed. In the preliminary analysis, a full factorial statistical model was used. However, in subsequent analyses, the complete model was reduced by removing the interaction term from the model, since its effect on the traits studied was not significant. Therefore, only the main effects of the treatment groups were analysed statistically using SPSS, and correlation coefficients were also calculated (11).

Results

Growth responses of calves fed AMR and SMR are presented in Table 2. Birth and weaning weights of the calves were similar among the treatments. Calves consuming AMR had numerically higher weights at 4 and 6 months of ages than those offered SMR; however, the differences were not statistically significant. On the other hand, 6-month weight was significantly ($P < 0.05$) affected by the sex of calves, and male calves exceeded female calves by 13.0 kg.

Daily body weight gains from birth to weaning, from weaning to 4 months of age, and from 4 to 6 months of ages for calves fed AMR were comparable those for calves offered SMR (Table 2). Daily weight gains obtained from various stages of calf growth were not affected significantly by the acidification of the milk replacer. However, sex of calves had a significant influence on the daily weight gains from birth to 6 months of age and from 4 to 6 months of age in favour of male calves ($P < 0.05$). Male calves had respectively 0.115 kg and 0.072 kg higher weight gains than females.

Gains in body measurements in the period between birth and 6 months of age are shown in Table 2. Calves consuming AMR had gains in body measurements similar to those in calves fed SMR. Sex of calves also did not have a significant influence on the gains in body measurements.

Dry matter (DM) intakes from liquid and starter as well as dry hay are presented in Table 3. Calves that consumed AMR had starter DM intake similar to that in calves fed SMR. Total DM intakes from milk replacer, starter and dry hay were not significantly affected by the acidification of the milk replacer in the preweaning

Table 2. Least squares means with standard deviations for body weights, weight gains and gains in body measurements.

	Milk Replacers			Sex		
	Acidified N = 10	Sweet N = 11	S	Male N = 10	Female N = 11	S
Body Weights (kg) at						
Birth	34.5 ± 1.4	33.1 ± 1.3	NS	34.6 ± 1.4	33.0 ± 1.3	NS
Weaning	42.2 ± 0.9	41.9 ± 0.8	NS	41.8 ± 1.0	42.4 ± 0.9	NS
4 months of age	92.0 ± 3.3	87.3 ± 2.9	NS	92.6 ± 3.3	86.7 ± 2.9	NS
6 months of age	141.3 ± 4.1	132.1 ± 3.7	NS	143.2 ± 4.1	130.2 ± 3.7	*
Daily Weight Gains (kg)						
Birth to weaning	0.249 ± 0.029	0.241 ± 0.026	NS	0.237 ± 0.029	0.253 ± 0.026	NS
Weaning to 4 months of age	0.593 ± 0.036	0.540 ± 0.032	NS	0.605 ± 0.036	0.528 ± 0.032	NS
4 to 6 months of age	0.808 ± 0.035	0.735 ± 0.031	NS	0.829 ± 0.035	0.714 ± 0.032	*
Birth to 6 months of age	0.598 ± 0.023	0.547 ± 0.021	NS	0.608 ± 0.023	0.536 ± 0.021	*
Gains in Body Measurements between Birth and 6 Months of Age (cm)						
Body length	32.4 ± 1.9	31.6 ± 1.7	NS	31.7 ± 1.9	32.3 ± 1.7	NS
Height at withers	24.5 ± 2.0	24.3 ± 1.8	NS	24.4 ± 2.0	24.4 ± 1.8	NS
Heart girth	45.8 ± 2.8	44.2 ± 2.6	NS	46.9 ± 2.8	43.1 ± 2.6	NS
Chest depth	16.6 ± 0.8	15.2 ± 0.7	NS	16.0 ± 0.8	15.8 ± 0.7	NS

S: Significance, NS: nonsignificant, *$P < 0.05$.

Table 3. Least squares means with standard deviations for dry matter intake.

	Milk Replacers			Sex		
	Acidified N = 10	Sweet N = 11	S	Male N = 10	Female N = 11	S
Dry matter intake from birth to weaning						
From milk replacer	9.54 ± 0.21	9.75 ± 0.19	NS	9.55 ± 0.22	9.74 ± 0.19	NS
From dry hay	2.69 ± 0.18	2.48 ± 0.16	NS	2.70 ± 0.18	2.48 ± 0.16	NS
From starter	6.58 ± 0.65	6.68 ± 0.58	NS	5.31 ± 0.65	7.95 ± 0.58	**
Total dry matter intake	18.81 ± 0.82	18.91 ± 0.74	NS	17.56 ± 0.82	20.17 ± 0.74	*
Dry matter intake from weaning to 4 months of age						
From dry hay	26.82 ± 1.77	29.84 ± 1.59	NS	27.20 ± 1.78	29.47 ± 1.60	NS
From starter	157.64 ± 12.33	158.58 ± 11.10	NS	147.13 ± 12.38	169.09 ± 11.13	NS
Total dry matter intake	184.46 ± 13.73	188.42 ± 12.36	NS	175.33 ± 13.79	198.56 ± 12.39	NS
Dry matter intake from 4 to 6 months of age						
From dry hay	42.33 ± 1.93	46.75 ± 1.74	NS	43.12 ± 1.94	45.96 ± 1.74	NS
From starter	210.34 ± 5.11	221.21 ± 4.60	NS	210.89 ± 5.13	220.66 ± 4.61	NS
Total dry matter intake	252.67 ± 6.69	267.96 ± 6.01	NS	254.01 ± 6.70	266.62 ± 6.02	NS
Dry matter intake from birth to 6 months of age						
From dry hay	71.85 ± 3.57	79.08 ± 3.21	NS	73.02 ± 3.58	77.91 ± 3.22	NS
From Starter	374.56 ± 16.78	386.49 ± 15.11	NS	363.33 ± 16.85	397.72 ± 15.14	NS
Total dry matter intake[1]	455.95 ± 19.53	475.33 ± 17.59	NS	445.90 ± 19.62	485.38 ± 17.62	NS

*P < 0.05, **P < 0.01,

[1] Dry matter intake of milk replacer was also included in the total dry matter intake.

period. However, male calves had a significantly lower amount of starter (P < 0.01) and total DM (P < 0.05) intakes than females. In the postweaning phase, total DM intakes of calves in the AMR and SMR treatment groups were not significantly different. Although the average feed intake values of calves consuming AMR were numerically lower than those of calves offered SMR, the differences were not significant (Table 3).

Efficiency of feed conversion in body weight gain in the preweaning period was similar for all treatments (Table 4). However, the overall feed efficiency ratio including preweaning and postweaning periods was better (P < 0.05) for calves fed AMR. In the postweaning period, average feed efficiency ratios of male calves were better (P < 0.05) than those of females.

Calf faecal consistency score measurements are shown in Table 5. Calves fed AMR exhibited significantly (P < 0.05) lower faecal consistency scores during days 4 to 17 than did calves offered SMR. During the same time period, male calves had significantly higher (P < 0.05) faecal consistency scores than females. Percent days with scours were high for calves fed SMR compared with those consuming AMR for days 4 to 17 (P < 0.01) and for days 4 to 35 (P < 0.05) (Table 4).

Total time spent for the intake of milk replacers was affected significantly (P < 0.01) by the type of milk replacer. Calves consuming AMR took a longer time (P < 0.01) to run out of all milk replacer in the pail than calves fed SMR. Total AMR and SMR feeding times were also significantly (P < 0.01) correlated (r = -0.675 and r = -0.721, respectively) with days in the preweaning period.

Frequency of the daily milk replacer intake of the calves was influenced significantly (P < 0.01) by the acidification process. The average frequency of the AMR intake was about 2 times greater than that of SMR intake. The frequency of the AMR intake was negatively

Table 4. Least squares means with standard deviations for feed efficiency ratio.

	Milk Replacers			Sex		
	Acidified N = 10	Sweet N = 11	S N = 10	Male N = 11	Female	S
Feed efficiency ratio between						
Birth and weaning	2.46 ± 0.40	2.49 ± 0.36	NS	2.35 ± 0.40	2.60 ± 0.36	NS
Weaning and 4 months of age	3.70 ± 0.30	4.31 ± 0.27	NS	3.43 ± 0.30	4.48 ± 0.27	*
4 and 6 months of age	5.16 ± 0.30	6.12 ± 0.27	NS	5.07 ± 0.30	6.21 ± 0.27	*
Birth and 6 months of age	4.25 ± 0.14	4.86 ± 0.12	*	4.08 ± 0.14	5.04 ± 0.12	**

S: Significance, NS: nonsignificant, *P < 0.05, **P < 0.01,

Table 5. Least squares means with standard deviations for average faecal consistency score, calf days with scours and behavioural traits of the calves.

	Milk Replacers			Sex		
	Acidified N = 10	Sweet N = 11	S N = 10	Male N = 11	Female	S
Average faecal consistency score [#]						
4 to 17 d	1.46 ± 0.07	1.68 ± 0.07	*	1.68 ± 0.07	1.45 ± 0.07	*
18 to 35 d	1.28 ± 0.05	1.34 ± 0.06	NS	1.36 ± 0.06	1.26 ± 0.05	NS
4 to 35 d	1.39 ± 0.03	1.45 ± 0.04	NS	1.50 ± 0.04	1.34 ± 0.04	*
Calf days with scours, % [1]						
4 to 17 d	2.85 ± 2.94	14.10 ± 3.12	**	11.96 ± 3.12	5.00 ± 2.94	NS
18 to 35 d	0.55 ± 1.43	3.88 ± 1.52	NS	3.33 ± 1.52	1.11 ± 1.43	NS
4 to 35 d	1.56 ± 1.79	8.36 ± 1.90	*	7.11 ± 1.90	2.81 ± 1.79	NS
Behavioural Traits						
Frequency of daily milk replacer intake from open pail	3.00 ± 0.20	1.47 ± 0.22	**	2.37 ± 0.22	2.10 ± 0.20	NS
Total time spent for the milk replacer intake (min)	3.51 ± 0.15	2.69 ± 0.16	**	3.27 ± 0.16	2.93 ± 0.15	NS
Time spent licking the walls of the pen (min)	0.38 ± 0.05	1.67 ± 0.06	**	0.39 ± 0.05	1.67 ± 0.06	**
Number of days needed to teach the calf how to drink milk replacer from an open pail without help	7.17 ± 1.25	3.50 ± 1.25	*	5.79 ± 1.25	4.87 ± 1.25	NS
Time spent looking around	2.58 ± 0.06	1.42 ± 0.07	**	2.32 ± 0.06	1.68 ± 0.07	**

S: Significance, NS: nonsignificant, *P < 0.05, **P < 0.01,
[#] 1 = normal (soft-solid consistency, no fluid), 2 = soft (semi-solid, mostly solid).
[1] Percent of calf days with faecal consistency score equal to or greater than 3.

($P < 0.01$) associated with days in the milk replacer feeding phase ($r = -0.543$).

Calves fed AMR spent a significantly greater ($P < 0.05$) number of days in order to learn to drink milk replacer from an open pail without help compared to those consuming SMR.

Sex of the calves did not significantly affect the frequency of the daily milk replacer intake, the total time spent for milk replacer intake or the number of days training to feed on the milk replacer from open pails.

Discussion

No significant differences were found between AMR- and SMR-fed calves in body weights determined at weaning, or 4 or 6 months of age (Table 2). Similar results were reported by Daenicke (12), who indicated that the weight development of calves fed AMR over the entire growth period was comparable to that of calves offered SMR. A significant influence of sex on the weights obtained at 6 months of age was demonstrated, as previously indicated by Turgut et al. (13), Yanar et al. (14), and Uğur et al. (15).

The average growth rate of AMR-fed calves was about 9.3% higher than that of young animals offered SMR for the whole rearing period. Although daily weight gains were in favour of calves consuming AMR compared with SMR, the differences were not significant. Comparable growth responses of calves fed AMR and SMR in restricted amounts were reported by Jaster et al. (8), who indicated an insignificant influence of the acidification of milk replacer on the weight gain of calves. Frelich et al. (4) and Skrivanova et al. (16) also found that there were no significant differences between the AMR and SMR groups in terms of daily weight gain. Average daily weight gain from birth to 6 months of age favoured male calves ($P < 0.05$) rather than female calves (0.608 vs. 0.536 kg, respectively). This result is in accordance with the findings published by Uğur et al. (17).

Acidifying of the milk replacers did not result in a significant effect on the gains in body measurements such as height at withers, body length, heart girth and chest depth. It was suggested that skeletal growth of the calves reared using AMR or SMR did not differ significantly from each other. These findings were supported by the results reported by Erickson et al. (18).

The amount of milk replacers given to the calves in the present study was limited to 8% of their birth weight and the amount was kept constant throughout the preweaning period. Therefore, calves offered AMR consumed a comparable amount of DM from milk replacer, dry hay and starter to those fed SMR. Similar DM intakes between AMR and SMR were also reported by Jaster et al. (8). DM intakes of the male and female calves that consumed either AMR or SMR were not significantly different during the postweaning phase. This finding is in agreement with the results reported by Nocek and Braund (19), who determined that total DM intakes of calves in the AMR and regular milk replacer groups were 2.7 and 2.8 kg, respectively, during the postweaning period.

Feed efficiency values obtained in the preweaning period were not significantly different among the milk replacer groups, as previously reported by Woodford et al. (3), and Jaster et al. (8). Woodford et al. (3) stated that calves fed SMR and AMR had feed efficiency ratios of 2.39 and 2.46, respectively. Jaster et al. (8) found that feed efficiency ratios for calves fed both SMR and AMR from days 3 to 28 (3.2 vs. 2.7) were not significantly different from each other. However, in the present study, overall feed efficiency ratios calculated for the entire experiment were superior ($P < 0.05$) for calves offered AMR compared with those for SMR-fed calves. This finding was in accordance with the results given by Panova and Chernuho (20). Male calves had generally better feed efficiency values than females.

Acidification of milk replacer appeared to lower calf faecal consistency scores. There was also a marked effect of acidification on reducing percent days with diarrhoea during days 4 to 17 (Table 5). Jaster et al. (8) reported that consumption of the AMR might have resulted in reducing pH in the lower alimentary tract of young calves. The high acidity might control and lower *Escherichia coli* proliferation (5,7) and promote lactobacilli growth in the digestive tract (8). Relatively higher acidity of the alimentary tract is likely to exhibit a bacteriostatic influence, therefore reducing the incidence of scours among calves (4,21).

All of the behavioural traits of calves consuming AMR and SMR were significantly influenced. The effect of sex had a significant ($P < 0.01$) effect on the time spent licking the walls of the hutches only.

Amount of labour spent for training the calves to drink milk replacer from an open pail without help differed significantly among the milk replacer groups. AMR-fed calves needed about 3.7 days more ($P < 0.05$) than those offered SMR. This result could be attributed to the strange sour taste of the AMR offered to the calves. The AMR-fed young animals required additional days to accustom to the consumption of AMR. Male and female calves did not differ significantly in terms of days required to learn to drink the replacer from an open pail.

Calves fed AMR consumed the replacer frequently in small meals ($P < 0.01$) compared with SMR-fed calves. Similar findings were reported by Erickson et al. (18), Nocek and Braund, (19) and Thickett et al. (22), who stated that as the milk replacer was acidified and tasted sour, calves did not drink excessive quantities all at one time. Comparable results were also obtained from the present study (Table 5). A significant ($P < 0.01$) negative correlation was also determined between frequency of AMR intake and days in the replacer feeding phase, which meant that as the feeding period proceeded the young animals got used to the taste of AMR.

In conclusion, the growth and feed efficiency traits of the Holstein Friesian calves reared under a new feeding program with AMR were not adversely affected; however, the incidence of diarrhoea of the calves was considerably lessened and the health status of the young animals was improved.

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