

# The Effect of Concentrate Feeding Levels on the Postweaning Performance of Holstein Friesian Calves

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**Abstract:** The influences of different levels of concentrate on the growth characteristics of Holstein Friesian calves reared under an original calf-rearing program were investigated in this study. Forty-one new-born calves (20 male and 21 female) were allocated to the four concentrate groups: 2, 2.5, 3 kg/calf and *ad libitum*. The calves were weaned at 5 weeks of age, and the trial lasted for 6 months.

The results with regard to weights at 6 months of age revealed that an increasing amount of concentrate supplementation resulted in a significantly ( $P < 0.01$ ) higher live weight. Furthermore, daily weight gains between birth and 6 months of age was also significantly higher ( $P < 0.01$ ) in the *ad libitum* group than in the 2, 2.5 and 3 kg/day groups. The highest overall gains in body measurements, for example body length and heart girth, were obtained from calves fed concentrate *ad libitum*. However, feed efficiency ratios were not significantly influenced by the various amounts of concentrate offered to calves.

The overall results suggest that the appropriate level of concentrate for the new calf-rearing program should be *ad libitum*.

**Key Words:** Holstein Friesian, Calves, Concentrate, Growth, Early Weaning, Feeding Level

## Kesif Yemle Besleme Seviyelerinin Siyah Alaca Buzağuların Sütten Kesim Sonrası Performansları Üzerine Etkileri

**Özet:** Bu çalışmada, farklı kesif yem seviyelerinin, yeni bir buzağı yetiştirme programı altında büyütülen Siyah Alaca buzağuların büyüme özellikleri üzerine etkileri araştırılmıştır. Kırk bir adet yeni doğan buzağı (20 erkek ve 21 dişi) 2, 2,5 3 kg/buzağı ve *ad libitum* kesif yem gruplarına dağıtılmışlardır. Buzağular 5 haftada sütten kesilmişler ve deneme 6 ay süreyle devam etmiştir.

Altı aylık yaştaki canlı ağırlıklara ait sonuçlar, artan besleme düzeyinin buzağularda çok önemli derecede ( $P < 0,01$ ) yüksek canlı ağırlığa neden olduğunu göstermiştir. Ayrıca, doğum-6 ay arası devrede günlük canlı ağırlık artışı 2, 2,5 ve 3 kg/gün kesif yem gruplarına kıyasla *ad libitum* grup lehine çok önemli derecede ( $P < 0,01$ ) yüksek olmuştur. Vücut uzunluğu, göğüs çevresi gibi vücut ölçülerindeki toplam canlı ağırlık artışları en fazla *ad libitum* seviyede kesif yem tüketen buzağulardan elde edilmiştir. Öte yandan, yemden yararlanma oranları buzağulara verilen kesif yem miktarlarından önemli derecede etkilenmemiştir.

Bu araştırmadan elde edilen genel sonuçlar, yeni buzağı yetiştirme programı için uygun kesif yem seviyesinin *ad libitum* düzeyde olması gerektiğini göstermiştir.

**Anahtar Sözcükler:** Siyah Alaca, Buzağular, Kesif Yem, Büyüme, Erken Sütten Kesim, Besleme Düzeyi

## Introduction

A series of studies has been conducted in order to develop a new calf-rearing program for dairy calves reared in the Eastern Anatolia region (1-6). In this program, calves are weaned early at 5 weeks of age and whole milk is offered to young animals once a day (every morning) (7). The amount of milk offered to calves is calculated based upon 8% of their birth weight and the quantity of milk is kept constant during the milk feeding period as suggested by Yanar et al. (5).

In this original calf rearing program, the first purpose is to reduce the amount of milk given to calves without causing any detrimental effect on their growth and feed efficiency ratio. Therefore, the amount of milk for human consumption would be increased and the feeding cost decreased because of early transition to dry feeds, which are more economical than whole milk. Besides the economical aspect of this program, it would diminish the number of pens necessary for milk-feeding and might lessen the number of calves on liquid-feeding program

within the same period. Therefore, calves could be cared for better and might have improved health during that period.

Previous studies (2,8) have revealed that the average six month weight and body measurements of Holstein Friesian calves raised under this program were lower than the breed standards for Holstein Friesian calves reported by Roy (9) and Heinrichs and Hargrove (10). Therefore, live weight at six months of age should be improved and standard breed weights attained. One of the ways to improve the performance of the calves up to 6 months of age is by giving the ideal amount of concentrate. In order to determine the optimum level of concentrate, several studies with different calf feeding programs were carried out in different countries (11-16). Common results obtained from these studies indicated that increasing the level of concentrate supplementation resulted in improvement in the live weight gains of calves. On the other hand, it should not be disregarded that the optimum level of concentrate could be dependent upon the calf-rearing program used. Therefore, the present study was undertaken to determine the optimum level of concentrate supplementation for Holstein Friesian calves raised under the new calf-feeding program.

**Materials and Methods**

The study was carried out at the Research Farm of Agricultural College at Atatürk University. Twenty male and 21 female new-born calves from the Holstein Friesian herd at this farm were utilised for this research. The calves were housed in a calf barn containing individual pens. The pens were furnished with hay and concentrate feeders and water-milk buckets. The calves were penned and fed individually throughout the trial.

After the calves were born, they were kept with their dams to suckle colostrum for 3 days. Then the calves were assigned randomly to four concentrate feeding levels, namely 2, 2.5, 3.0 kg and *ad libitum*. In the pre-weaning period, calves were fed milk at 8% of their birth weights, and the quantity of milk was kept constant during the milk feeding period. Milk was given using a water-milk bucket once a day (every morning). All calves were weaned at 5 weeks of age.

Fresh water was available in the pens during the experiment. Grass hay in good quality was supplied up to

500 g daily from birth to weaning and *ad libitum* from weaning to 6 months of age. Two different kinds of concentrate, called calf starter I and II, were used in this study. Calf starter I was fed from birth to 4 months of age, and starter II was offered after 4 months of age. The chemical compositions of the starters and hay are presented in Table 1.

Table 1. Chemical Compositions of Concentrates and Grass Hay Used in the Study.

Nutrients (%)	Calf Starter I	Calf Starter II	Grass Hay
Dry Matter	94.30	94.25	93.05
Protein	18.54	17.42	5.88
Ether Extract	1.83	1.81	1.34
Ash	7.37	10.29	7.12
Cellulose	6.62	5.12	34.64

The quantities of starter and hay remaining in the feeders were weighed daily and the amount of feed consumed was determined. The live weight was recorded at weekly intervals before weaning and at fortnightly intervals from weaning to 6 months of age. Additionally, the live weights and body measurements (height at withers, heart girth, body length, chest depth and foreshank circumference) were obtained at birth, weaning, and 4 and 6 months of ages.

The data were analysed by using a 4 x 2 completely randomised factorial experimental design. ANOVA analysis was carried out using the SAS statistics package (17). Duncan’s multiple comparison test was also utilised (18).

**Results**

The live weights of Holstein Friesian calves were obtained weekly prior to weaning and fortnightly from weaning to 6 months of age (Figure). The live weights determined weekly were quite similar in the pre-weaning period, but differences among the concentrate supplementation groups became striking, especially after 11 weeks of age.

The live weights obtained at various stages of the growth of Holstein Friesian calves are presented in Table 2. The body weights at birth, weaning and 4 months of age in the different concentrate supplementation groups were not significantly affected by the levels of

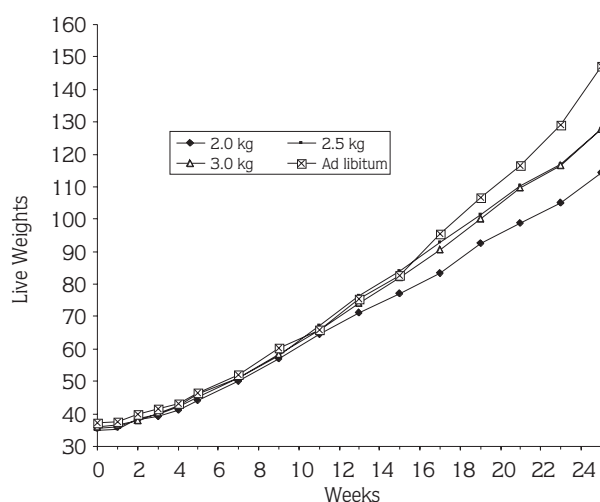


Figure. Live Weights of Holstein Friesian Calves Obtained at Weekly Intervals Prior to Weaning and at Fortnightly Intervals from Weaning to 6 Months of Age.

concentrate. However, the average 6-month weights of calves supplemented with concentrate *ad libitum* were significantly higher (33.1, 19.3 and 20.3 kg) than those of calves that consumed 2, 2.5 and 3 kg of concentrate,

respectively. In addition, the sex of calves resulted in significant ( $P < 0.05$ ) weight differences at 6 months of age; males were 9.22 kg heavier than female calves.

Data with regard to daily weight gains at various growing stages are tabulated in Table 3. Weight gains between birth and weaning and from weaning to 4 months of age were not significantly affected by levels of concentrate. On the other hand, the highest overall daily weight gains from birth to 6 months of age were observed for calves in the *ad libitum* group and averaged 0.173 kg/day higher ( $P < 0.01$ ) than for the 2 kg level of concentrate. The weight gains between 4 and 6 months of ages were also significantly higher ( $P < 0.01$ ) in the *ad libitum* group than in the other groups. Furthermore, sex had a significant ( $P < 0.05$ ) effect on weight gain from birth to 6 months of age.

The results obtained with respect to feed efficiency revealed that the amount of dry matter consumed per kg weight gain from birth to weaning, from weaning to 4 months of age, and from 4 to 6 months of ages were not significantly affected by varying levels of concentrate supplementation (Table 4).

Table 2. Least Square Means for Live Weights Obtained at Various Stages of the Growth of Holstein Friesian Calves.

Traits	n	Birth Weight	Weaning Weight	4-Month Weight	6-Month Weight
Level of Concentrate					
2.0	10	35.50 ± 1.44	44.10 ± 1.47	83.20 ± 3.49	114.10 ± 4.20 <sup>c</sup>
2.5	10	35.10 ± 1.43	45.10 ± 1.47	93.00 ± 3.49	127.90 ± 4.20 <sup>b</sup>
3.0	11	35.95 ± 1.37	45.90 ± 1.47	95.60 ± 3.49	126.90 ± 4.17 <sup>b</sup>
<i>ad libitum</i>	10	37.10 ± 1.44	46.40 ± 1.47	95.60 ± 3.49	147.20 ± 4.20 <sup>a</sup>
Significance		NS	NS	NS	**
Sex					
Male	20	36.25 ± 0.20	45.60 ± 1.04	93.90 ± 2.47	133.65 ± 2.98
Female	21	35.58 ± 1.00	45.15 ± 1.02	87.01 ± 2.42	124.43 ± 2.91
Significance		NS	NS	NS	*
Sex x Level of Concentrate					
Male x 2.0	5	36.00 ± 2.02	45.60 ± 2.08	89.60 ± 4.94	122.40 ± 5.94
Male x 2.5	5	36.20 ± 2.03	46.00 ± 2.08	98.60 ± 4.94	134.40 ± 5.94
Male x 3.0	5	35.40 ± 2.03	44.80 ± 2.08	89.20 ± 4.94	124.40 ± 5.94
Male x <i>ad libitum</i>	5	37.40 ± 2.02	46.00 ± 2.08	98.20 ± 4.94	153.40 ± 5.94
Female x 2.0	5	35.00 ± 2.02	42.60 ± 2.08	76.80 ± 4.94	105.80 ± 5.94
Female x 2.5	5	34.00 ± 2.02	44.20 ± 2.08	87.40 ± 4.94	121.40 ± 5.94
Female x 3.0	6	36.50 ± 1.85	47.00 ± 1.90	90.83 ± 4.51	129.50 ± 5.42
Female x <i>ad libitum</i>	5	36.80 ± 2.02	46.80 ± 2.08	93.00 ± 4.94	141.00 ± 5.94
Significance		NS	NS	NS	NS

NS Non-significant

\*  $P < 0.05$

\*\*  $P < 0.01$

Table 3. Least Square Means for Daily Weight Gains of Holstein Friesian Calves (kg).

Traits	n	Birth to Weight	Weaning to 4 Months of	4 Months to 6 Months of Age	Birth to 6-Month of Age
Level of Concentrate					
2.0	10	0.246 ± 0.027	0.465 ± 0.036	0.506 ± 0.032 <sup>c</sup>	0.431 ± 0.021 <sup>c</sup>
2.5	10	0.286 ± 0.027	0.570 ± 0.036	0.572 ± 0.032 <sup>bc</sup>	0.509 ± 0.021 <sup>b</sup>
3.0	11	0.284 ± 0.026	0.525 ± 0.034	0.605 ± 0.030 <sup>b</sup>	0.499 ± 0.020 <sup>b</sup>
<i>ad libitum</i>	10	0.266 ± 0.027	0.586 ± 0.036	0.846 ± 0.032 <sup>a</sup>	0.604 ± 0.021 <sup>a</sup>
Significance		NS	NS	**	**
Sex					
Male	20	0.267 ± 0.019	0.575 ± 0.025	0.625 ± 0.022	0.534 ± 0.016
Female	21	0.274 ± 0.019	0.498 ± 0.024	0.613 ± 0.022	0.487 ± 0.014
Significance		NS	*	NS	*
Sex x Level of Concentrate					
Male x 2.0	5	0.274 ± 0.039	0.524 ± 0.051	0.537 ± 0.045	0.474 ± 0.030
Male x 2.5	5	0.280 ± 0.039	0.626 ± 0.051	0.587 ± 0.045	0.538 ± 0.030
Male x 3.0	5	0.268 ± 0.039	0.529 ± 0.051	0.577 ± 0.045	0.488 ± 0.030
Male x <i>ad libitum</i>	5	0.246 ± 0.039	0.622 ± 0.051	0.905 ± 0.045	0.636 ± 0.030
Female x 2.0	5	0.217 ± 0.039	0.407 ± 0.051	0.475 ± 0.045	0.388 ± 0.030
Female x 2.5	5	0.292 ± 0.039	0.514 ± 0.051	0.557 ± 0.045	0.479 ± 0.030
Female x 3.0	6	0.300 ± 0.035	0.522 ± 0.046	0.634 ± 0.045	0.510 ± 0.030
Female x <i>ad libitum</i>	5	0.285 ± 0.039	0.550 ± 0.051	0.787 ± 0.045	0.571 ± 0.030
Significance		NS	NS	NS	NS

NS Non-significant  
 \* P < 0.05  
 \*\* P < 0.01

Traits	n	Birth to Weaning	Weaning to 4 Months of Age	4 to 6 Months of Age
Level of Concentrate				
2.0	10	2.902 ± 0.416	4.329 ± 0.247	5.641 ± 0.340
2.5	10	2.747 ± 0.416	4.050 ± 0.247	5.820 ± 0.340
3.0	11	2.396 ± 0.398	4.978 ± 0.236	6.489 ± 0.326
<i>ad libitum</i>	10	2.691 ± 0.416	4.600 ± 0.247	6.560 ± 0.340
Significance		NS	NS	NS
Sex				
Male	20	2.523 ± 0.294	4.198 ± 0.174	6.224 ± 0.241
Female	21	2.844 ± 0.288	4.780 ± 0.171	6.030 ± 0.236
Significance		NS	*	NS
Sex x Level of Concentrate				
Male x 2.0	5	2.644 ± 0.589	3.988 ± 0.349	5.523 ± 0.482
Male x 2.5	5	2.459 ± 0.589	3.721 ± 0.349	5.733 ± 0.482
Male x 3.0	5	2.420 ± 0.589	4.784 ± 0.349	6.930 ± 0.482
Male x <i>ad libitum</i>	5	2.571 ± 0.589	4.300 ± 0.349	6.711 ± 0.482
Female x 2.0	5	3.160 ± 0.589	4.671 ± 0.349	5.758 ± 0.482
Female x 2.5	5	3.034 ± 0.589	4.380 ± 0.349	5.906 ± 0.482
Female x 3.0	6	2.371 ± 0.537	5.172 ± 0.349	6.048 ± 0.440
Female x <i>ad libitum</i>	5	2.812 ± 0.589	4.900 ± 0.349	6.409 ± 0.482
Significance		NS	NS	NS

Table 4. Least Square Means for Feed Efficiency<sup>1</sup> Values Obtained at Different Phases of the Growth of Calves.

<sup>1</sup> Feed Efficiency = Amount of consumed dry matter from hay and concentrate / weight gain  
 NS Non-significant  
 \* P < 0.05  
 \*\* P < 0.01

The findings concerning the grass hay, concentrate and total feed dry matter intakes are presented in Tables 5, 6 and 7. Dry matter intake from concentrate and total feed were significantly ( $P < 0.01$ ) raised by increasing levels of concentrate in the rations (Tables 5, 7). However, none of the treatments significantly affected the dry matter intake of grass hay.

Although the gains in all body measurements were higher in calves in the *ad libitum* group, only differences in the body length and the heart girth were statistically significant (Table 8).

## Discussion

The results concerning the birth weight of Holstein Friesian calves reared in harsh conditions in Eastern Anatolia confirmed the findings of previous studies carried out in this region (8,19). However, the average birth weight of Holstein calves in the USA was reported to be 6.1 kg heavier than reported here (9).

Differences in the weaning weights of calves in different concentrate groups were not statistically different, as previously reported by Carvalho et al. (13). This result could be attributed to the consumption of similar amounts of calf starter in the pre-weaning period, in spite of different quantities of concentrate being offered to them. However, the 6-month weights of Holstein Friesian calves fed concentrate *ad libitum* were higher than those in the other groups. This result was in accordance with findings of Leaver (20), Bartholomew et al. (12), Kertz et al. (21), and Gonzalez and Cortes (22).

In the present study, the average 6-month weights of Holstein Friesian calves fed concentrate *ad libitum* were higher than those found in a previous study using the same calf-rearing program (8). This indicates that the 6-month weights of Holstein Friesian calves raised under the new feeding program can be improved by increasing the level of concentrate up to the *ad libitum* level. On the other hand, the 6-month weights of Holstein Friesian calves reared in the Eastern Anatolia region are still

Table 5. Least Square Means for Dry Matter (Concentrate) Intake of Holstein Friesian Calves between Birth and 6 Months of Age (kg).

Traits	n	Birth-Weaning	Weaning-4 months	4 Months-6 months	Birth-6 months
Level of Concentrate					
2.0	10	7.27 ± 0.75	123.59 ± 8.90 <sup>b</sup>	113.18 ± 7.13 <sup>d</sup>	244.04 ± 14.72 <sup>c</sup>
2.5	10	9.67 ± 0.75	157.10 ± 8.90 <sup>ab</sup>	143.43 ± 7.13 <sup>c</sup>	310.20 ± 14.72 <sup>b</sup>
3.0	11	8.92 ± 0.72	177.27 ± 8.53 <sup>a</sup>	171.46 ± 6.83 <sup>b</sup>	357.65 ± 14.09 <sup>b</sup>
<i>ad libitum</i>	10	8.89 ± 0.75	179.55 ± 8.90 <sup>a</sup>	273.97 ± 7.13 <sup>a</sup>	462.41 ± 14.72 <sup>a</sup>
Significance		NS	**	**	**
Sex					
Male	20	7.94 ± 0.53	161.65 ± 6.30	182.16 ± 5.04	351.75 ± 10.41
Female	21	9.44 ± 0.52	157.11 ± 6.16	168.85 ± 4.94	335.39 ± 10.19
Significance		NS	NS	NS	NS
Sex x Level of Concentrate					
Male x 2.0	5	8.36 ± 1.06	134.01 ± 12.59	111.30 ± 10.09	256.67 ± 20.82
Male x 2.5	5	9.48 ± 1.06	156.80 ± 12.59	143.73 ± 10.09	310.00 ± 20.82
Male x 3.0	5	8.06 ± 1.06	174.60 ± 12.59	170.89 ± 10.09	353.54 ± 20.82
Male x <i>ad libitum</i>	5	5.88 ± 1.06	181.19 ± 12.59	299.72 ± 10.09	486.79 ± 20.82
Female x 2.0	5	6.19 ± 1.06	113.18 ± 12.59	112.05 ± 10.09	231.41 ± 20.82
Female x 2.5	5	9.86 ± 1.06	157.40 ± 12.59	143.12 ± 10.09	310.39 ± 20.82
Female x 3.0	6	9.79 ± 0.97	179.95 ± 11.50	172.02 ± 9.21	361.76 ± 19.01
Female x <i>ad libitum</i>	5	11.91 ± 1.06	177.90 ± 12.59	248.22 ± 10.09	438.02 ± 20.82
Significance		**	NS	*	NS

NS Non-significant

\*  $P < 0.05$

\*\*  $P < 0.01$

Table 6. Least Square Means for Dry Matter (Grass Hay) Intake of Holstein Friesian Calves between Birth and 6 Months of Age (kg).

Traits	n	Birth-Weaning	Weaning-4 months	4-Months-6 months	Birth-6 months
Level of Concentrate					
2.0	10	1.83 ± 0.22	38.39 ± 2.68	58.25 ± 3.29	99.01 ± 5.29
2.5	10	1.64 ± 0.22	34.77 ± 2.68	58.18 ± 3.29	94.59 ± 0.59
3.0	11	2.03 ± 0.21	36.32 ± 2.57	57.37 ± 3.15	95.73 ± 5.07
<i>ad libitum</i>	10	2.14 ± 0.22	40.55 ± 2.68	62.02 ± 3.29	104.71 ± 0.59
Significance		NS	NS	NS	NS
Sex					
Male	20	1.90 ± 0.15	39.22 ± 1.90	62.40 ± 2.32	103.52 ± 3.74
Female	21	1.92 ± 0.15	36.06 ± 1.86	55.52 ± 2.28	93.50 ± 3.66
Significance		NS	NS	*	NS
Sex x Level of Concentrate					
Male x 2.0	5	2.09 ± 0.31	39.94 ± 3.79	62.31 ± 4.65	104.34 ± 7.49
Male x 2.5	5	1.64 ± 0.31	38.86 ± 3.79	61.28 ± 4.65	101.77 ± 7.49
Male x 3.0	5	1.84 ± 0.31	34.76 ± 3.79	57.11 ± 4.65	93.72 ± 7.49
Male x <i>ad libitum</i>	5	2.04 ± 0.31	43.32 ± 3.79	68.89 ± 4.65	114.24 ± 7.49
Female x 2.0	5	1.57 ± 0.31	37.91 ± 3.79	54.19 ± 4.65	93.68 ± 7.49
Female x 2.5	5	1.64 ± 0.31	30.69 ± 3.79	55.08 ± 4.65	87.41 ± 7.49
Female x 3.0	6	2.22 ± 0.28	37.88 ± 3.46	57.64 ± 4.24	97.74 ± 6.83
Female x <i>ad libitum</i>	5	2.25 ± 0.31	37.78 ± 3.79	55.16 ± 4.65	95.19 ± 7.49
Significance		NS	NS	NS	NS

NS Non-significant

\* P < 0.05

Table 7. Least Square Means for Total Dry Matter Intake of Holstein Friesian Calves between Birth and 6 Months of Ages (kg).

Traits	n	Birth-Weaning	Weaning-4 months	4 Months-6 months	Birth-6 months
Level of Concentrate					
2.0	10	20.89 ± 0.92	162.52 ± 9.53 <sup>b</sup>	171.43 ± 8.63 <sup>c</sup>	354.84 ± 17.30 <sup>c</sup>
2.5	10	22.96 ± 0.92	191.88 ± 9.53 <sup>ab</sup>	201.61 ± 8.63 <sup>bc</sup>	416.44 ± 17.30 <sup>bc</sup>
3.0	11	22.89 ± 0.88	213.59 ± 9.12 <sup>a</sup>	228.83 ± 8.26 <sup>b</sup>	465.31 ± 16.57 <sup>b</sup>
<i>ad libitum</i>	10	23.35 ± 0.92	220.09 ± 9.53 <sup>a</sup>	335.39 ± 8.63 <sup>a</sup>	579.44 ± 17.30 <sup>a</sup>
Significance		NS	**	**	**
Sex					
Male	20	21.88 ± 0.65	200.87 ± 6.74	244.56 ± 6.10	467.31 ± 12.23
Female	21	23.17 ± 0.64	193.17 ± 6.60	224.37 ± 5.97	440.71 ± 11.98
Significance		NS	NS	*	NS
Sex x Level of Concentrate					
Male x 2.0	5	22.40 ± 1.30	173.95 ± 13.48	176.61 ± 12.20	372.97 ± 24.47
Male x 2.5	5	23.13 ± 1.30	195.66 ± 13.48	205.00 ± 12.20	423.79 ± 24.47
Male x 3.0	5	21.65 ± 1.30	209.36 ± 13.48	228.00 ± 12.20	459.01 ± 24.47
Male x <i>ad libitum</i>	5	20.33 ± 1.30	224.51 ± 13.48	368.60 ± 12.20	613.45 ± 24.47
Female x 2.0	5	19.38 ± 1.30	151.09 ± 13.48	166.24 ± 12.20	336.71 ± 24.47
Female x 2.5	5	22.79 ± 1.30	188.09 ± 13.48	198.21 ± 12.20	409.09 ± 24.47
Female x 3.0	6	24.13 ± 1.19	217.82 ± 12.30	229.66 ± 12.20	471.61 ± 22.34
Female x <i>ad libitum</i>	5	26.38 ± 1.30	215.67 ± 13.48	303.38 ± 12.20	545.43 ± 24.47
Significance		**	NS	*	NS

NS Non-significant

\* P < 0.05

\*\* P < 0.01

Table 8. Least Square Means for Gains in the Body Measurements of Holstein Friesian Calves between Birth and 6 Months of Age (cm).

Traits	n	Body Length	Height at Withers	Chest Depth	Heart Girth	Foreshank Circumference
Level of Concentrate						
2.0	10	29.4 ± 1.4 <sup>b</sup>	23.6 ± 1.3	15.2 ± 0.6	36.4 ± 1.5 <sup>b</sup>	2.1 ± 0.3
2.5	10	33.1 ± 1.4 <sup>ab</sup>	26.3 ± 1.3	16.2 ± 0.6	41.2 ± 1.5 <sup>a</sup>	2.6 ± 0.3
3.0	11	31.5 ± 1.3 <sup>b</sup>	26.1 ± 1.2	16.3 ± 0.6	40.7 ± 1.4 <sup>a</sup>	2.6 ± 0.3
<i>ad libitum</i>	10	35.9 ± 1.4 <sup>a</sup>	28.9 ± 1.3	16.9 ± 0.6	44.4 ± 1.5 <sup>a</sup>	3.3 ± 0.3
Significance		*	NS	NS	**	NS
Sex						
Male	20	32.3 ± 1.0	26.2 ± 0.9	16.2 ± 0.4	42.2 ± 1.0	2.7 ± 0.2
Female	21	32.6 ± 0.9	26.2 ± 0.9	16.1 ± 0.4	39.1 ± 1.0	2.6 ± 0.2
Significance		NS	NS	NS	*	NS
Sex x Level of Concentrate						
Male x 2.0	5	29.6 ± 1.9	25.2 ± 1.9	14.8 ± 0.8	37.8 ± 2.1	2.3 ± 0.4
Male x 2.5	5	35.0 ± 1.9	26.2 ± 1.9	17.6 ± 0.8	45.2 ± 2.1	2.8 ± 0.4
Male x 3.0	5	29.2 ± 1.9	24.4 ± 1.9	15.4 ± 0.8	40.8 ± 2.1	2.6 ± 0.4
Male x <i>ad libitum</i>	5	35.4 ± 1.9	29.2 ± 1.9	17.0 ± 0.8	45.2 ± 2.1	3.3 ± 0.4
Female x 2.0	5	29.2 ± 1.9	22.0 ± 1.9	15.6 ± 0.8	35.0 ± 2.1	2.2 ± 0.4
Female x 2.5	5	31.2 ± 1.9	26.4 ± 1.9	14.8 ± 0.8	37.2 ± 2.1	2.4 ± 0.4
Female x 3.0	6	33.5 ± 1.8	27.6 ± 1.7	17.1 ± 0.7	40.5 ± 1.9	2.7 ± 0.3
Female x <i>ad libitum</i>	5	36.4 ± 1.9	28.6 ± 1.9	16.8 ± 0.8	43.6 ± 2.1	3.3 ± 0.4
Significance		NS	NS	NS	NS	NS

NS Non-significant

\* P &lt; 0.05

\*\* P &lt; 0.01

relatively lower than those raised in the USA (141.0 vs. 168.6 kg for females) (10). The weight differences could be attributed to the lower birth weight of calves used in the present study (35.1-37.1 kg vs. 42 kg) and different environmental conditions in Eastern Anatolia including altitude and harsh climatic and geographical conditions.

Calves supplemented concentrate at the *ad libitum* level gained higher ( $P < 0.01$ ) live weight from weaning to 6 months of age than the others. Similar results have been reported by several researchers (13,16,20,23). The growth pattern of the calves supplemented with various amounts of concentrate is presented in Figure 1. The characteristic shape of the curves was in agreement with the findings of Gonzalez and Cortes (22).

The feed efficiency values (the amount of dry matter of concentrate and hay consumed per kg weight gain) in different phases of growth were not significantly affected by various levels of concentrate supplementation. These findings were in accordance with the results of Plaza et al. (14), who reported that the feed efficiency values of

Holstein Friesian calves supplemented with different amounts of concentrate from 11 to 30 days of age, and from 31 to 70 days of age were not significantly different.

The amounts of concentrate consumed by the calves between birth and 6 months of age increased by raising the levels of concentrate available in the diet as expected. Additionally, the total dry matter intake of the Holstein calves was influenced significantly ( $P < 0.01$ ) by the amount of concentrate offered. Similar results were previously reported by Plaza et al. (14) and Harvey and Burns (23), who noted that the average concentrate intake and total dry matter intake were significantly higher for calves given concentrate at a higher level compared with those given restricted concentrate.

Gains in body measurements, such as body length and heart girth, of the calves in the *ad libitum* group were significantly higher than those of the other calves fed varying levels of concentrate. This was in agreement with findings of Kertz et al. (21).



The overall results of this study reveal that the appropriate level of the concentrate for the original calf-rearing program in the Eastern region of Anatolia should be *ad libitum*. If the amount of concentrate as suggested

by the present study is given to Holstein Friesian calves raised under the new calf-feeding program, they will have a better growth performance, and their feed efficiency values will not be adversely affected.

## References

1. Yanar, M., Tüzemen, N., Ockerman, H.W.: The effect of weaning ages on the growth characteristics and feed efficiencies of Simmental calves. *Agricul. Equip. Int.*, 1993; 45 (3-4): 38-39.
2. Yanar, M., Tüzemen, N., Aydın, R., Akbulut, Ö., Ockerman, H.W.: Growth characteristics and feed efficiencies of the early weaned Brown-Swiss, Holstein Friesian and Simmental calves reared in Turkey. *Indian J. Dairy Sci.* 1994; 47 (4): 273-275.
3. Yanar, M., Tüzemen, N., Ockerman, H.W.: Comparative growth characteristics and feed conversion efficiencies in Brown Swiss calves weaned at five, seven and nine weeks of ages. *Indian J. Anim. Sci.*, 1994; 64 (9): 981-983.
4. Aydın, R., Emsen, H., Yanar, M., Tüzemen, N.: The effect of levels of milk feeding on the performance of Brown-Swiss calves raised in Turkey. *Agricul. Equip. Int.*, 1994; 48 (3-4): 18-20.
5. Yanar, M., Uğur, F., Tüzemen, N., Aydın, R.: Growth performance of Brown Swiss calves reared on two milk feeding schedules. *Indian J. Anim. Sci.*, 1997; 67 (12): 1114-1116.
6. Yanar, M., Tüzemen, N., Aydın, R., Uğur, F.: Early weaning of Brown Swiss calves raised in Eastern Turkey. *Agricul. Equip. Int.*, 1995; 47 (1-2): 20-21.
7. Yanar, M., Ockerman, H.W.: Milk feeding frequency of Brown Swiss calves in the cold semi-arid climate environment of Turkey. *Asian Livestock*, 1993; 18 (4): 46-48.
8. Uğur, F., Yanar, M., Tüzemen, N., Özhan, M.: Effects of cold and warm milk feeding in the growth characteristics of Holstein Friesian calves. *Agricul. Equip. Int.*, 1996; 48 (9-10): 137-138.
9. Roy, J.H.B.: *The Calf*. Butterworths, London, p. 43-47, 1980.
10. Heinrichs, A.J., Hargrove, G.L.: Standards of weight and height for Holstein heifers. *J. Dairy Sci.*, 1987; 70 (3): 653-660.
11. Raicu, E., Şerban, D., Spulber, M., Alexoiu, V., Georgescu, G., Dzig, G.: Effect of a diet restricted in or without concentrate for limited times on fattening young Romanian Brown cattle. *Nutrition Abst. Revi., Seri. B.*, 1978; 61 (4): 262.
12. Bartholomew, P.W., McLauchlan, W., Chestnut, D.M.B.: Effect of unwilted and wilted silages and hay supplemented with different amounts of concentrate, on live weight gain of calves. *Anim. Prod.*, 1981; 32 (3): 307-313.
13. Carvalho, E.M.R., Carvalho, S.R., Leal, S.M., Nascimento, F.L., Aronovich, S.: Early weaning of dairy cattle with restriction. *Revista Socied. Brasileira Zootec.*, 1983; 3 (12): 535-550.
14. Plaza, J., Garcia, H., Fernandez, E.: Effect of the feed management on the performance of calves until 4 months of age. *Cuban J. Agricul. Sci.*, 1988; 22: 265-271.
15. Aronen, I., Lampila, M., Hepola, H.: Comparison of diets based on grass silage, hay or oat straw supplemented with four levels of concentrates in the feeding of growing Ayrshire bulls. *Nutrition Abst. Revi. Seri. B.*, 1994; 64 (8): 537.
16. Anuez, M., Delgado, A., Hernandez, H.: A study of concentrates and forages with *ad libitum* molasses urea for increasing the efficiency of growing fattening Cattle: I. Effect of the levels of concentrates. *Biological Abst.*, 1996; 102 (5): 34.
17. SAS: *SAS User's Guide, Statistics*, SAS Institute, Inc., Cary, USA, 1986.
18. Duncan, D.B.: Multiple range and multiple F tests. *Biometrics*, 1955; 11: 1.
19. Yanar, M., Yüksel, S., Zulkadir, U.: Replacement of whole milk by milk replacer in the ration of Holstein Friesian calves raised in Eastern Turkey. *Indian J. Anim. Sci.*, 2000; 70 (9): 977-979.
20. Leaver, J.D.: Rearing of dairy cattle. 4. Effect of concentrate supplementation on the live-weight gain and feed intake of calves offered roughages *ad libitum*. *Anim. Prod.*, 1973; 17 (1): 43-52.
21. Kertz, A.F., Prewitt, L.R., Ballam, J.M.: Increased weight gain and effects on growth parameters of Holstein heifer calves from 3 to 12 months of age. *J. Dairy Sci.*, 1987; 70 (8): 1612-1622.
22. Gonzalez, H., Cortes, C.: Evaluation of concentrate supplementation in European Holstein calves raised under grazing. I. From birth to six months of age. *Avan. Prod. Anim.*, 1988; 1-2 (13): 185-190.
23. Harvey, W.R., Burns, J.C.: Forage species, concentrate feeding level and cow management system in combination with early weaning. *J. Anim. Sci.*, 1988; 66 (11): 2722-2727.