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Research Article

The Growth and Survival Characteristics of Holstein Female Calves Weaned at Various Ages*

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Abstract: This study was carried out at Kırklereli - Karacadağ Farm of Tikveşli Agricultural Company. It was aimed to investigate the growth and survival characteristics and the most cost-effective weaning age of Holstein female calves weaned at various ages. In the study, 100 female calves born single from Holstein heifers were used and they were divided randomly into five groups each having 20 calves. The calves were weaned at 28 (Group 28), 35 (Group 35), 42 (Group 42), 56 (Group 52) and 70 (Group 70) days of age.

The live weights at 180th day of age of calves in 28, 35, 42, 56 and 70th day weaning groups were 160.0 kg, 162.4 kg, 167.7 kg, 169.3 kg and 175.4 kg, respectively. In terms of 180th day live weight, Group 70 had the highest result and the differences between this group and groups 28 and 35 were statistically significant. The differences between the other groups for 180th day live weight were not significant.

There was no mortality in the 100 calves during the entire 180 days of the study.

The results of this study showed that early weaning of female calves could be applied in farms with good feeding and management conditions. This practice will provide the cheaper and healthy breeding of female calves until the age they start production.

Key Words: Calf, Holstein, growth, weaning age, survival

Değişik Yaşlarda Sütten Kesilen Siyah Alaca Dişi Buzağılarda Büyüme ve Yaşama Gücü

Özet: Bu araştırma, Tikveşli Tarım İşletmeleri Kırklareli - Karacadağ Çiftliği'nde yürütülmüştür. Araştırmada, değişik yaşlarda sütten kesilen buzağıların, ileriki yaşlardaki büyüme ve yaşama gücü düzeyinin ortaya konması ve ekonomik sütten kesme yaşının belirlenmesi amaçlanmıştır. Çalışmada, Siyah-Alaca gebe düvelerden aynı dönemde tek doğan 100 dişi buzağı tesadüfi olarak ayrılarak her birinde 20 buzağı bulunan 5 grup oluşturulmuştur. Buzağılar 28. gün (Grup 28), 35. gün (Grup 35), 42. gün (Grup 42), 56. gün (Grup 56) ve 70. günde (Grup 70) sütten kesilmişlerdir.

Büyüme özelliklerinden 180. gündeki canlı ağırlık düzeyleri Grup 28, 35, 42, 56 ve 70 için sırasıyla 160,0 kg, 162,4 kg, 167,7 kg, 169,3 kg ve 175,4 kg olarak gerçekleşmiştir. Buzağıların 180. gündeki canlı ağırlıkları için Grup 70 ile Grup 56 ve 42 arasındaki fark önemsizken, Grup 70 ile Grup 35 ve 28 arasındaki fark istatistiki açıdan önemli olmuştur. Grup 56, 42, 35 ve 28 arasındaki farklılıklar ise önemsiz bulunmuştur.

Araştırmada, 180 gün boyunca incelenen 100 dişi buzağıdan ölen olmamıştır.

Bu çalışmada, dişi buzağıların üretime başlayacağı zamana kadar daha ucuza ve daha sağlıklı olarak yetiştirilmesi için buzağıların erken sütten kesilmesinin, bakım ve beslemenin iyi olduğu işletmelerde uygulanabileceği ve işletmeye ekonomik olarak avantajlar sağlayacağından yetiştiricilere önerilebileceği sonucuna varılmıştır.

Anahtar Sözcükler: Buzağı, siyah alaca, büyüme, sütten kesme yaşı, yaşama gücü

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Introduction

The profitableness in cattle breeding is greatly influenced by the cost-effectiveness of the rearing of breeding animals until the age they begin production (1).

The feeding of a calf from birth to the age of two weeks is dependent entirely on the milk in its diet. During this period abomasum is the main digestive organ. In the first three days after birth the calf is fed with colostrum. After colostrum, calf feed is given in addition to the milk (2,3). The weaning age might exceed ten weeks in calves that are not well taken care of (4). The ratio of rumen to abomasum, which is 0.5 at birth, should be 1.5 at the time of weaning (3). Also, the calf should be capable of consuming 750-1000 g feed for two days consecutively at the time of weaning.

The calves with higher birth weights are weaned at earlier ages. Although the weaning age and the amount of the milk is shortened, if enough calf feed is being given, the growth of the calf is not being affected (5). The daily weight gain is the most efficient factor in milking period. In addition, the feed efficiency of calves in this period is at its peak (6).

The birth weight and 180th day live weight of Holstein calves were reported 37.9-41.8 kg and 126.3-168.6 kg, respectively (7-12). The survival rates until 180th day of age were 88.0-97.5% and the differences between the calf groups weaned at different ages were not found significant (8,9,11-15). It was reported that the feed consumption of the calves increased after weaning (13-15-18) and the differences between the calf groups in terms of live weight gain diminished until the age of 6 months after weaning (10,13,14). It was reported that there were not significant differences between the growth results in different periods of calves, which were weaned at different ages and feeding programs (10,13,17,19).

This study was carried out to investigate the growth characteristics of Holstein female calves weaned at different ages. The results of the study will show the effects of the investigated weaning age and feeding program on the growth characteristics and breeding costs of female calves. Consequently, the most suitable weaning age will be determined and recommended to the breeders.

Materials and Methods

As the calf material in the study, 100 Holstein similar aged female calves born single from Holstein heifers, which were imported from Germany, were used.

At the 4th day after birth, the female calves were divided randomly into five groups each having 20 calves. The groups were named after the day of weaning. For instance, the group weaned at 28th day of age is defined as Group 28.

All the groups were fed with colostrum during the first three days after birth. In terms of the milk feeding program, Group 28 was fed with 4 l (2 l in the morning and 2 l in the evening) in 4-28th days; Group 35 was fed with 4 l in 4-28th days and 2 l (all in the evening) in 29-35th days; Group 42 was fed with 5 l (2.5 l in the morning and 2.5 l in the evening) in 4-15th days, 4 l in 16-33rd days and 2 l in 34-42nd days; Group 56 was fed with 5 l in 4-19th days, 4 l in 20-42nd days and 2 l in 43-56th days and Group 70 was fed with 5 l in 4-21st days, 4 l in 22-52nd days and 2 l in 53-70th days. The milk consumption of the groups were 100 l, 114 l, 150 l, 200 l and 250 l, respectively.

From the 4th day of age on, all the calves in the groups were given ad-libitum calf feed containing 18% crude protein and 2800 kcal/kg metabolisable energy and water.

After the 60th day of age grass hay containing 8.56% crude protein and 1240 kcal/kg metabolisable energy were added ad-libitum to the diet. After the 4th month of age the calves were fed ad-libitum with the ration containing 12% crude protein and 2500 kcal/kg metabolisable energy, which was produced by the farm.

The birth weights of calves were weighed after their bodies were dried. To collect the growth data, the calves were weighed before feeding in the mornings with a scale sensitive to 100 g. The absolute growth results of the calves were determined by the linear interpolation of the weights obtained in consecutive weightings. The growths of the calves were observed in different periods until the 180th day of age.

The feed consumptions of the calves until the 30th day of age were measured daily in individual boxes. Group feeding was performed between the 30th and 70th days of age.

Cost comparisons were made only with regard to feed and milk consumption costs. In the financial analyses, the sum of the feed and milk costs was defined as the total cost. The feed and milk consumption cost values of each weaning group were calculated according to the rates at the time this study was conducted.

In the statistical comparisons between the groups in terms of growth characteristics, one-way analyses of variance (ANOVA) was used and the significance controls of the differences between the groups were determined by Duncan test (20). SPSS was used for the statistical analyses.

Results

The live weights in different periods from birth to 180th day of age of Holstein female calves weaned at 28, 35, 42, 56 and 70 days are given in Table 1.

The live weights at the 28 and 35th days of calves increased proportional to their milk consumptions. The live weights at 42, 56 and 70th days of age of calves were not parallel to the amounts of milk consumed by calves. These results are likely to be due to the effects of weaning stress caused by weaning in different dates on the live weights of calves in the mentioned periods.

After recovering the weaning stress, the calves reached to a similar growth performance that they had in the milk-consuming period. At 180th day of age the least milk consuming Group 28 attained the lowest live weight whereas the highest milk consuming Group 70 reached the highest live weight.

The periodical live weight gains and the Duncan test between groups results until 180th day of age of the female Holstein calves weaned at 28, 35, 42, 56 and 70 days of age are presented in Table 2.

There was no mortality in the 100 calves investigated during the entire 180 days of the study. Moreover, although there was a slight decrease in the live weight gain in each of the groups at weaning, no significant disease was observed.

The feed consumptions until 70th day of age of the Holstein female calves weaned at 28, 35, 42, 56 and 70 days were given in Table 3.

The amount of milk and calf feed that the calves consumed until they were 70 days of age were calculated by taking the price of the food bought by the farm and the price of the milk sold by the farm into consideration (milk parity: milk / feed = 1.265). The results of the calculations made according to this value and the average 70th day live weight gains of the calf groups are presented in Table 4.

Table 1. The live weights of Holstein calves from birth to 180 days of age (kg)

Days	n	Group 28		Group 35		Group 42		Group 56		Group 70	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
Birth	20	39.2^{a}	1.03	38.9^{a}	1.22	40.5^{a}	0.96	39.4^{a}	1.10	38.1^{a}	0.89
28th	20	47.7^{b}	0.91	47.5^{b}	1.06	48.9^{ab}	0.97	49.5^{ab}	0.89	51.5^{a}	1.16
35th	20	50.7^{b}	1.06	51.0^{b}	1.04	53.1^{ab}	1.10	54.0^{ab}	1.11	54.8^{a}	1.29
42nd	20	56.5^{ab}	1.12	54.9^{b}	1.10	57.5^{ab}	1.26	58.4^{ab}	1.30	58.9^{a}	1.39
56th	20	65.6^{a}	1.12	64.6^{a}	1.39	68.1^{a}	1.44	68.3^{a}	1.61	67.4^{a}	1.50
70th	20	73.4^{b}	1.13	74.8^{ab}	1.97	77.8^{ab}	1.71	79.8^{a}	2.16	77.8^{ab}	1.94
90th	20	84.0^{c}	1.31	87.5^{bc}	2.24	91.7^{ab}	2.00	95.1^{a}	2.52	94.3^{a}	2.20
105th	20	91.8^{c}	1.62	97.3^{bc}	2.56	102.0^{ab}	2.20	105.8^{a}	2.82	106.9^{a}	2.39
120th	20	107.3^{b}	1.64	108.7^{b}	2.63	113.5^{ab}	2.30	116.3^{a}	3.10	120.1^{a}	2.82
135th	20	119.2^{b}	2.02	119.9^{b}	2.93	125.4^{ab}	2.59	126.7^{ab}	3.34	131.5^{a}	2.56
150th	20	133.6^{b}	0.73	135.1^{ab}	3.11	139.8^{ab}	2.66	139.8^{ab}	3.60	142.8^{a}	2.38
165th	20	146.8^{b}	0.89	148.7^{b}	3.64	153.7^{ab}	2.83	154.5^{ab}	3.90	159.1^{a}	2.56
180th	20	160.0^{b}	3.05	162.4^{b}	4.32	167.7^{ab}	3.04	169.3^{ab}	4.32	175.4^{a}	2.89

^{a}, ^{b}, ^{c}: The differences between the means of groups carrying various letters in the same line are significant ($P < 0.05$)

Table 2. The live weight gains of Holstein calves until 180 days of age (kg).

Days	n	Group 28		Group 35		Group 42		Group 56		Group 70	
		Mean	SE	Mean	SE	Mean	SE	Mean	SE	Mean	SE
0-28th	20	8.59^{b}	0.484	8.62^{b}	0.725	8.44^{b}	0.653	10.13^{b}	0.675	13.44^{a}	0.546
28-35th	20	2.92^{c}	0.484	3.47^{abc}	0.226	4.25^{ab}	0.335	4.48^{a}	0.418	3.33^{bc}	0.252
35-42nd	20	5.84^{a}	0.253	3.94^{b}	0.282	4.39^{b}	0.323	4.45^{b}	0.383	4.05^{b}	0.245
42-56th	20	9.12^{ab}	0.480	9.70^{ab}	0.601	10.52^{a}	0.587	9.91^{ab}	0.791	8.46^{b}	0.324
56-70th	20	7.78^{b}	0.537	12.54^{a}	2.848	9.78^{ab}	0.523	11.53^{ab}	0.937	10.42^{ab}	1.067
70-90th	20	10.60^{c}	0.670	12.70^{b}	0.616	14.29^{b}	0.638	14.53^{b}	0.612	16.48^{a}	0.647
90-105th	20	7.82^{c}	0.532	9.77^{b}	0.415	10.32^{b}	0.507	10.68^{b}	0.490	12.68^{a}	0.483
105-120th	20	15.43^{a}	1.070	11.29^{bc}	0.898	11.53^{bc}	0.584	10.58^{c}	0.426	13.19^{b}	0.641
120-135th	20	11.96^{a}	0.569	10.96^{a}	0.704	11.92^{a}	0.566	10.32^{a}	0.753	11.35^{a}	0.640
135-150th	20	14.46^{a}	1.186	14.57^{a}	1.192	14.37^{a}	0.429	13.00^{ab}	0.558	11.34^{b}	0.639
150-165th	20	13.14^{b}	0.509	13.16^{b}	0.780	13.93^{b}	0.396	14.79^{ab}	0.759	16.27^{a}	0.697
165-180th	20	13.14^{b}	0.509	13.17^{b}	0.781	13.92^{b}	0.394	14.79^{ab}	0.759	16.26^{a}	0.701

^{a}, ^{b}, ^{c}: The differences between the means of groups carrying various letters in the same line are significant ($P < 0.05$).

Table 3. The feed consumption of Holstein calves until 70 days of age (kg)*

Groups	Days					Total
	0-28	28-35	35-42	42-56	56-70	
Group 28	6.59 (0.235)	11.81 (1.687)	12.87 (1.839)	28.30 (2.021)	31.00 (2.214)	90.57
Group 35	6.57 (0.234)	5.90 (0.843)	13.00 (1.857)	28.15 (2.011)	29.10 (2.079)	82.72
Group 42	6.95 (0.248)	4.87 (0.696)	6.31 (0.901)	19.85 (1.418)	30.20 (2.157)	68.18
Group 56	5.64 (0.201)	3.77 (0.539)	6.08 (0.869)	18.81 (1.344)	30.55 (2.182)	64.85
Group 70	5.47 (0.195)	3.42 (0.489)	3.96 (0.566)	12.76 (0.911)	28.91 (2.065)	54.52

* The values in parentheses show the amount of daily feed consumption of calves in that period

Table 4. The milk and feed unit values of feed and milk costs of calves until 70 days of age and the live weight gains of calves from birth to 70 days of age

Groups	Total consumption		Milk equivalent of feed (l)	Total cost as milk (l)	Live weight gain of calves until 70 days of age (kg)
	Milk (l)	Feed (kg)			
Group 28	100	90.57	71.60	171.6	34.2
Group 35	114	82.72	65.40	179.4	35.9
Group 42	150	68.18	53.90	203.9	37.3
Group 56	200	64.85	51.30	251.3	40.4
Group 70	250	54.52	43.10	293.1	39.7

The cost of 1 kg live weight gain of the groups in milk units was calculated by dividing the live weight of the groups until 70th day of age with the sum of the total feed and milk expenditures. The comparisons of the costs of other groups in percentages (%) according to Group 35 and the determination of the differences between the total costs of the other groups with Group 35 in milk units, which is calculated by dividing to milk price, are given in Table 5.

Discussion

The birth weights of the calves in the present study were similar to the results of different studies (7,8,11,12). The live weights of calves at 6th month of age (160.0-175.4 kg) were similar to the results reported (167.1-168.6 kg) in different studies (9,10) and were higher than the results (126.3-143.2 kg) in some others (8,12).

At 6 months of age the differences between the live weights of Group 28, Group 35, Group 42 and Group 56 are not significant. This result is similar to the results of different studies carried out on Holstein calves (10,14,15,17,19). Only the differences between Group 70 with Groups 28 and 35, which had the lowest live weights, were statistically significant.

In terms of the live weight gains from 35th day to 180th day, Group 35, Group 42 and Group 56 exhibited a similar pattern; Group 28 reached these groups at 105th day of age and showed similar live weight gains afterwards. These results are supporting the studies reporting that the gaps in the live weights of the groups weaned at different ages begin to diminish after weaning and disappear at the age of 6 months (10,14,15).

Group 70 in the present study generally gained higher live weights than other groups. This may be due to the milk consumptions during the first 3 weeks of the calves in this group being more than the other groups, rather than their total milk consumptions. Additionally, the calves in Group 70 did not experience weaning stress owing to the sequential reduction of milk. When the live weight gains are observed, it might be expected that the other groups can reach a level where they might close this gap with Group 70.

The absence of any differences between the groups in terms of survival rates supports the results of different studies, which reported that the weaning age did not have any effect on survival rate (11,13-15). The survival rate in the present study (100%) is higher than those reported (88.0-97.5%) in different studies (7-9,11,14,15).

When the feed consumptions are investigated, it can be seen that the amount of milk consumed by the calves in the milk-feeding period affected the amount of feed consumed. There was a significant increase in the feed consumption following the weaning since the calves had to obtain all the required nutrient needs from the feed. The result of the present study determining that the feed consumption of the calves increased after weaning supports the results of the previously published studies (13-15,16-18).

In terms of the total costs, the decrease in the costs of early-weaned calves in the present study is in accordance with the results of Towery (4).

In cost analyses, while the most economical group per 1 kg live weight gain was Group 35, there was a very little difference between Group 35 and Group 28, which

Table 5. The cost of 1 kg weight gain of calves; the differences of the cost of 1 kg weight gain according to Group 35 (%) and the milk equivalent of total cost differences (l)

Groups	Milk equivalent of the cost of 1 kg weight gain (l)	According to Group 35	
		Differences of the cost of 1 kg weight gain (%)	Milk equivalent of total cost (l)
Group 28	5.018	0.4	-7.8
Group 35	4.997	-	-
Group 42	5.467	9.4	+24.5
Group 56	6.220	24.5	+71.9
Group 70	7.383	47.7	+113.7

was weaned at an earlier age. When the live weights at 180th day of age of Group 28 and 35 were investigated, it could be seen that there was no significant difference. However, it was determined that Group 56 and 70 were not economical and applicable for the farms. Although the increasing labour and stand costs, which increase as the weaning time prolonged, are not included in the study, the present results show that the extension of the weaning time causes an increase in the costs. Additionally, when the using of milk by humans is taken into consideration, although there was no calf-rearing cost difference among the groups, feeding programs with less milk might be considered as a better use of the national resources. The results of the present study showed the possibility of high economical benefit for the groups fed with less milk.

In dairy cattle breeding, as heifers can only contribute to production approximately after 25 months of age, their care and feeding constitute a continuous expenditure until this age. For this reason, companies have to raise these animals most economically during this period.

In conclusion, to raise female calves cheaper and healthier until the age that they start production, the earlier weaning of calves can be applied in farms providing appropriate feeding and management conditions. This programme can be recommended to the breeders as it provides financial advantages.

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