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# THE EFFECT OF AVERAGE DAILY GAIN AND AGE AT FIRST CALVING ON REPRODUCTIVE AND MILK PRODUCTION TRAITS OF BROWN SWISS AND HOLSTEIN FRIESIAN CATTLE

B. BAYRAM[1*], M. YANAR[2] and O. AKBULUT[2]
[1] *Gumushane University, Aydin Dogan Vocational School, Kelkit 29600, Gumushane, Turkey*
[2] *Ataturk University, Department of Animal Science, College of Agriculture, 25240 Erzurum, Turkey*

## Abstract

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The purpose of the study was to determine the effects of average daily gain and age at first calving on the reproductive and milk production traits of Brown Swiss (BS) and Holstein Friesian (HF) cattle. For this purpose, daily gains and ages at first calving were divided into two groups which were below the average called as the "slow" or "early" groups and above the average named as "moderate" or "late" groups respectively. BS heifers in the moderate group reached the first insemination age and first calving age 103.7 and 101.7 days earlier ($P<0.01$) than these in the slow group respectively. The corresponding values for HF heifers were 37.8 and 29.5 days respectively and were not significant. While the average daily gain had negative effects on reproduction traits following the first calving, the daily gain of BS had no effect on the milk production traits in all parities. HF heifers in the moderate group had higher ($P<0.05$) actual (585 kg) and 305 days milk yield (324 kg) in the second parity.

Early calving in both breeds resulted in a significant ($P<0.05$) reduction in the actual and 305-days milk yield in the first parity. Early calving caused a significant decrease ($P<0.05$) in the actual milk yield, 305-days milk yield, actual milk fat and 305-days milk fat yield of BS cows in the first parity. Either early or late calving in BS didn't affect on milk traits in second and third parities. The early calving in HF lowered significantly ($P<0.05$) the actual and 305-days milk yield in first lactation. However, late calving in HF resulted in lower actual milk yield, 305-days milk yield, actual milk fat yield and 305-days milk fat yield in third parity.

*Key words:* heifers, daily gain, age at first calving, reproduction traits, milk yield, Holstein Friesian, Brown Swiss
*Abbreviations:* HF: Holstein Friesian, BS: Brown Swiss, ADG: Average Daily Gain

## Introduction

Raising dairy heifers is very important aspect of whole farm management that can be characterized as a long-duration, high-cost period (Zanton and Heinrichs, 2005). The improvement of the overall heifer replacement system is a possible strategy which enables us to reduce costs associated with a dairy

[*]*E-mail: bbayram@atauni.edu.tr*

herd (Bouska et al., 2007). Raising replacement heifers represents up to 20 % of total production costs in dairy farming (Heinrichs, 1993).

The cost of rearing replacement heifers can be reduced by means of accelerating the growth rate and by earlier breeding, thus decreasing age at first calving (Hoffman et al., 1996; Pietersma et al., 2006). In literature, there are controversial results of the reports. Some of the studies have reported that increasing average daily gain (ADG) before puberty resulted in a decrease in milk production (Hoffman et al., 1996; Van Amburgh et al., 1998; Lammers et al., 1999; Abeni et al., 2000; Radcliff et al., 2000). Gardner et al. (1977) also reported that Holstein heifers calved at 19.7 month produced 1052 kg less milk during their first lactation than heifers calved at 26.9 month. On the other hand, Pirlo et al. (1997) and Waldo et al. (1998) stated no significant association between ADG and milk production. For this reason, this two opposite relation must be well balanced in the dairy management.

The objectives of the study were to determine the effects of average daily gains and ages at first calving on the some reproductive and milk production traits of Brown Swiss (BS) and Holstein Friesian (HF) heifers reared in high altitude of Eastern Region of Turkey.

## Material and Methods

In this study, data pertaining weights and milk yield traits of BS and HF heifers raised in the Research Farm of Agricultural College at Ataturk University, Erzurum, Turkey between 1990 and 2004 were used. In this farm, the newborn calves were kept with their dams for first 3 days and were allowed to consume adequate amount of colostrum. Calves were weaned at 5-8 weeks of ages. After the weaning, the calves were fed dry hay *ad libitum* and 1.5-2.0 kg of calf starter including 17% raw protein. From six months to the first calving, heifers consumed daily dry hay *ad libitum* and 1-2 kg/day of concentrate per animal. In this farm the cows were milked twice a day and each animal was given 2 kg concentrate feed in each milking. Semi-intensive animal husbandry was applied in this farm. In the late fall and winter, the animals were kept in closed tethered barn and in the spring and summer they were housed in the open shed barn.

The birth weight of newborn calves was obtained within two hours after the birth. Other weights at weaning, fourth and sixth months of ages were also determined. In this farm, live weights of all animals were measured periodically twice a year, firstly when they were taken to the pasture in the spring and secondly when they returned from the pasture in the fall. The birth weight, weight in the sixth, twelfth and eighteenth months of 184 BS and 102 HF cows were compiled and their weights in various periods and some milk traits records were evaluated. By using the data, daily live gains from birth to 18-month age and the ages at first calving were calculated for each animal. The results are presented in Table 1.

In order to determine the effects of daily gains and ages at first calving on some reproduction and milk production traits, data were classified into two groups. BS heifers which had a daily gain below average were called as "slow group" (ADG < 475.0 g/day) while those with a daily gain above average were named as "moderate group" (ADG > 475.0 g/day). Similarly, HF heifers which had a daily gain BA were called as "slow group" (ADG < 499.2 g/day) while those with a daily gain AA were named as "moderate group" (ADG > 499.2 g/day). In the classification according to the ages at first calving, BS heifers calved at before

**Table 1**
**Average daily gains and age first calving age for BS and HF**

| Breed | N | Average daily gain, g/day | Age at first calving, months | Age at first calving, days |
|---|---|---|---|---|
| Brown Swiss | 184 | 475.0 ± 5.7 | 34.9 ± 0.4 | 1061 ± 10.9 |
| Holstein Friesian | 102 | 499.2 ± 6.9 | 32.4 ± 0.4 | 986 ± 11.9 |

1061 days of ages and HF heifers calved at before 986 days of ages were called as "early group" and the others were named as "late group".

At the beginning, the effects of the calving years and calving seasons were statistically investigated and then data were standardized according to the significant sources of the variation. The standardized data were statistically analyzed by using 3 different preliminary statistical models which included all two and three ways interactions. Insignificant interactions were excluded from the final models. Reproduction traits (first insemination age, age at first calving, first and second calving intervals and number of days open in the first and second calving) were analyzed according to the following mathematical model in SPSS computer statistics program (SPSS, 2004);

$$Y_{ijk} = \mu + a_i + b_j + (a \times b)_{ij} + e_{ijk}$$

Where;
$Y_{ijk}$ = Dependent variable,
$\mu$ = Overall mean,
$a_i$ = Effect of breeds (l: 1, 2; 1: HF; 2: BS),
$b_j$ = Effect of average daily gain (k: 1, 2; 1: slow group, 2: moderate group),
$(a \times b)_{ij}$ = Interaction between average daily gain groups and breeds
$e_{ijk}$ = Residual.

Milk production traits (actual milk yield, 305-days milk yield, lactation duration, percentage of milk fat , actual milk fat yield and 305-days milk fat yield) were analyzed statistically by using the two following mathematical models;

**Model 1:**

$$Y_{ijkl} = \mu + a_i + b_j + c_k + (a \times b \times c)_{ijk} + e_{ijkl}$$

Where;
$Y_{ijkl}$ = Dependent variable,
$\mu$ = Overall mean,
$a_i$ = Effect of breeds (i: 1, 2; 1: HF; 2: BS),
$b_j$ = Effect of parity (j: 1, 2, 3),
$c_k$ = Effect of average daily gain (k: 1, 2; 1: slow group, 2: moderate group),
$(a \times b \times c)_{ijk}$ = Interactions among average daily gain groups, parities and breeds,
$e_{ijkl}$ = Residual.

**Model 2:**

$$Y_{ijkl} = \mu + a_i + b_j + c_k + (a \times b \times c)_{ijk} + e_{ijkl}$$

Where:
$Y_{ijkl}$ = Dependent variable,
$\mu$ = Overall mean,
$a_i$ = Effect of breeds (i: 1, 2; 1: HF; 2: BS),
$b_j$ = Effect of parity (j: 1, 2, 3),
$c_k$ = Effect of ages at first calving (k: 1, 2; 1: early group, 2: late group),
$(a \times b \times c)_{ijk}$ = Interactions among average daily gain groups, parities and breeds,
$e_{ijkl}$ = Residual.

Phenotypic correlations between average daily gain and age at first calving with milk production traits were also calculated in this study. The correlations were also calculated by using the SPSS statistics computer program (SPSS, 2004).

## Results

Least square means with standard deviations for first insemination age (days), age at first calving (days), first and second calving interval (days), days open in first and second calving of BS and HF cows in both slow and moderate daily gain groups are presented in Table 2. First insemination age and age at first calving of BS cows in the moderate group were significantly ($P<0.01$) lower than these in the slow group. Second calving interval and days open in second calving for BS and HF cows in slow group were also significantly ($P<0.05$) lower than these in the moderate group.

Least square means with standard deviations for actual milk yield, 305-days milk yield, lactation duration, actual milk fat yield, 305 days milk fat yield of BS and HF cows in different parities and groups of ADG are tabulated in Table 3. Most of the milk production traits studied was not significantly influenced

**Table 2**
**The effect of daily gain groups on some reproduction traits**

| Traits | Breed | Average daily gain, g/day | | | | S |
|---|---|---|---|---|---|---|
| | | N | Slow group | N | Moderate group | |
| First insemination age (days) | BS | 96 | 767.5 ± 13.99 | 84 | 663.8 ± 15.09 | ** |
| | HF | 53 | 654.5 ± 15.60 | 46 | 616.7 ± 16.50 | ns |
| Age at first calving (days) | BS | 96 | 1109.1± 13.99 | 84 | 1007.4 ± 15.09 | ** |
| | HF | 54 | 984.8 ± 14.49 | 46 | 955.3 ± 15.90 | ns |
| First calving interval (days) | BS | 66 | 409.0 ± 10.2 | 60 | 430.8 ± 12.42 | ns |
| | HF | 44 | 419.7 ± 13.6 | 29 | 434.8 ± 22.2 | ns |
| Days open in first calving | BS | 65 | 137.8 ± 10.1 | 59 | 149.9 ± 10.2 | ns |
| | HF | 44 | 145.9 ± 13.6 | 28 | 129.0 ± 12.6 | ns |
| Second calving interval | BS | 28 | 380.5 ± 12.6 | 30 | 416.4 ± 12.5 | * |
| | HF | 24 | 400.7 ± 15.5 | 16 | 473.3 ± 30.5 | * |
| Days open in second calving | BS | 28 | 121.0 ± 13.6 | 30 | 165.5 ± 17.0 | * |
| | HF | 24 | 132.9 ± 15.1 | 16 | 195.5 ± 28.4 | * |

BS: Brown Swiss, HF: Holstein Friesain, S: Significance, ns: non-significant, * P<0.05, ** P<0.01

by the slow and moderate daily gain groups in both breeds.

In Table 4, the least square means with standard deviations for actual milk yield, 305-days milk yield, lactation duration, actual milk fat yield, 305 milk days fat yield of BS and HF cows in different parities and groups of the ages at first calving are given. As can be seen in Table 4, age at first calving for BS heifers did not have any effects on the milk production traits in the second and the third parities. Lactation duration of the cows in both breeds was not significantly affected by the early or late ages at first calving.

Phenotypic correlations between daily gain and ages at first calving with milk production traits are presented in Table 5. The correlation values are generally low and statistically non-significant. On the other hand, the correlation between ADG and age at first calving in BS and the correlation of calving interval with age at first calving in HF cows were negative and significant (Table 6).

## Discussion

The heifers in the moderate group reached first insemination at a younger age than the slower growing animals (Table 2). This difference between two groups was 103.7 days (P<0.01) for BS heifers. However, it was 37.8 days and non-significant for HF heifers. Similarly, some previous studies (Gardner et al., 1977; Lammers et al., 1999; Radcliff et al., 2000; Bouska et al., 2007) reported that heifers with a high daily gains attain their first insemination age earlier than those with a slow rate of weight gain. On the other hand, results of the other studies have suggested that the daily gain has no effect on first insemination age (Choi et al., 1997; Abeni et al., 2000; MacDonald et al., 2005). However, the average daily gain in the prepubertal stage is an important factor thought to be effective on the first insemination age. Since the heifers with a high daily gain in the same breed complete their development earlier and they are expected to reach their reproduction age earlier.

In both breeds, ages at first calving for the heifers in slow group were greater than these in moderate group. While the difference (101.7 days) was statistically significant (P<0.05) in BS heifers, the difference (29.5 days) in HF heifers was not significant (Table 2). Likewise, Hoffman et al. (1996) and Van Amburgh et al. (1998) reported that the heifers with a rapid daily gain calved at a younger age than those of the

**Table 3**
**Effect of daily gain on milk production traits**

| Traits | Breed | Parities | Average daily gain, g/day | | | | S |
|---|---|---|---|---|---|---|---|
| | | | N | Slow group | N | Moderate group | |
| Actual milk yield | BS | 1 | 85 | 2893 ± 80.80 | 79 | 2959 ± 83.8 | ns |
| | BS | 2 | 61 | 3111 ± 102.9 | 53 | 3153 ± 108.4 | ns |
| | BS | 3 | 27 | 3269 ± 140.9 | 29 | 3487 ± 135.9 | ns |
| | HF | 1 | 48 | 3231±113.1 | 46 | 3259 ± 115.6 | ns |
| | HF | 2 | 33 | 3189 ± 179.7 | 29 | 3774 ± 191.7 | * |
| | HF | 3 | 22 | 3323 ± 174.3 | 17 | 3658 ± 198.1 | ns |
| 305-days milk yield | BS | 1 | 85 | 2673 ± 58.9 | 79 | 2718 ± 61.1 | ns |
| | BS | 2 | 61 | 2912 ± 77.8 | 53 | 2936 ± 82.0 | ns |
| | BS | 3 | 27 | 3224 ± 117.0 | 29 | 3228 ± 112.9 | ns |
| | HF | 1 | 48 | 2985 ± 91.7 | 46 | 3016 ± 93.6 | ns |
| | HF | 2 | 33 | 2960 ± 115.5 | 29 | 3284 ± 130.2 | * |
| | HF | 3 | 22 | 3203 ± 141.5 | 17 | 3441 ± 160.9 | ns |
| Lactation duration | BS | 1 | 85 | 323 ± 6.13 | 79 | 329 ± 6.36 | ns |
| | BS | 2 | 61 | 313 ± 8.50 | 53 | 316 ± 8.879 | ns |
| | BS | 3 | 27 | 285 ± 9.99 | 29 | 328 ± 9.64 | ** |
| | HF | 1 | 48 | 330 ± 8.15 | 46 | 336 ± 8.32 | ns |
| | HF | 2 | 33 | 319 ± 14.8 | 29 | 354 ± 15.8 | ns |
| | HF | 3 | 22 | 302 ± 9.15 | 17 | 314 ± 11.2 | ns |
| Percentage of milk fat, % | BS | 1 | 85 | 4.00 ± 0.03 | 79 | 3.97 ± 0.03 | ns |
| | BS | 2 | 61 | 3.99 ± 0.08 | 53 | 4.11 ± 0.08 | ns |
| | BS | 3 | 27 | 3.84 ± 0.09 | 29 | 3.89 ± 0.09 | ns |
| | HF | 1 | 48 | 3.56 ± 0.05 | 46 | 3.54 ± 0.05 | ns |
| | HF | 2 | 33 | 3.58 ± 0.06 | 29 | 3.51± 0.07 | ns |
| | HF | 3 | 22 | 3.50 ± 0.08 | 17 | 3.27 ± 0.10 | * |
| Actual milk fat yield | BS | 1 | 85 | 113.1 ± 3.43 | 79 | 115.8 ± 3.58 | ns |
| | BS | 2 | 61 | 123.9 ± 5.28 | 53 | 125.2 ± 5.28 | ns |
| | BS | 3 | 27 | 124.1 ± 5.93 | 29 | 138.0 ± 5.72 | ns |
| | HF | 1 | 48 | 116.7 ± 4.86 | 46 | 115.5 ± 4.96 | ns |
| | HF | 2 | 27 | 114.8 ± 0.07 | 29 | 134.5 ± 0.07 | + |
| | HF | 3 | 22 | 117.3 ± 6.67 | 17 | 120.0 ± 7.51 | ns |
| 305-days milk fat yield | BS | 1 | 85 | 105.0 ± 2.66 | 79 | 107.3 ± 3.78 | ns |
| | BS | 2 | 61 | 115.2 ± 4.50 | 53 | 118.2 ± 4.70 | ns |
| | BS | 3 | 27 | 122.4 ± 4.93 | 29 | 125.6 ± 4.76 | ns |
| | HF | 1 | 48 | 110.4 ± 4.13 | 46 | 107.6 ± 4.22 | ns |
| | HF | 2 | 27 | 104.5 ± 4.80 | 29 | 116.3 ± 5.12 | ns |
| | HF | 3 | 22 | 113.0 ± 5.60 | 17 | 112.7 ± 6.39 | ns |

BS: Brown Swiss, HF: Holstein Friesain, S: Significance, ns: non-significant,
+: Marginal Significance ($P < 0.10$)
*$P<0.05$, ** $P<0.01$,

**Table 4**
**The effect of age at first calving on milk production traits**

| Traits | Breed | Parities | Age at first calving | | | | S |
|---|---|---|---|---|---|---|---|
| | | | N | Early group | N | Late group | |
| Actual milk yield | BS | 1 | 78 | 2809 ± 108.1 | 86 | 3101 ± 103.5 | * |
| | BS | 2 | 55 | 3144 ± 113.3 | 58 | 3168 ± 120.1 | ns |
| | BS | 3 | 27 | 3474 ± 146.6 | 29 | 3486 ± 140.1 | ns |
| | HF | 1 | 53 | 3099 ± 119.4 | 41 | 3336 ± 128.0 | * |
| | HF | 2 | 38 | 3669 ± 166.4 | 29 | 3316 ± 195.1 | ns |
| | HF | 3 | 23 | 3618 ± 138.2 | 15 | 3410 ± 160.1 | * |
| 305 days milk yield | BS | 1 | 78 | 2598 ± 75.8 | 86 | 2798 ± 72.5 | * |
| | BS | 2 | 55 | 2897 ± 86.0 | 58 | 2953 ± 91.2 | ns |
| | BS | 3 | 27 | 3196 ± 134.0 | 29 | 3316 ± 128.0 | ns |
| | HF | 1 | 53 | 2853 ± 92.8 | 41 | 3175± 99.5 | * |
| | HF | 2 | 38 | 3244 ± 91.4 | 29 | 3142 ± 107.2 | * |
| | HF | 3 | 23 | 3441 ±105.1 | 15 | 3230 ± 122.1 | * |
| Lactation duration | BS | 1 | 78 | 322.5 ± 8.2 | 86 | 338 ± 7.90 | ns |
| | BS | 2 | 55 | 323.2 ± 10.2 | 58 | 314 ± 150.7 | ns |
| | BS | 3 | 27 | 329.1 ± 11.5 | 29 | 312.6 ±11.0 | ns |
| | HF | 1 | 53 | 335. 1 ±8.92 | 41 | 316 ± 9.57 | ns |
| | HF | 2 | 38 | 348.5 ± 12.4 | 29 | 329.0 ± 14.8 | ns |
| | HF | 3 | 23 | 316.3 ±11.8 | 15 | 311.4 ± 13.7 | ns |
| Fat % | BS | 1 | 78 | 3.91 ± 0.07 | 86 | 3.99 ± 0.07 | ns |
| | BS | 2 | 55 | 4.14 ±0.07 | 58 | 3.97 ± 0.07 | ns |
| | BS | 3 | 27 | 4.01 ± 0.09 | 29 | 3.82 ± 0.08 | ns |
| | HF | 1 | 53 | 3.52 ± 0.05 | 41 | 3.61 ± 0.06 | + |
| | HF | 2 | 38 | 3.67 ± 0.05 | 29 | 3.45 ± 0.06 | ns |
| | HF | 3 | 23 | 3.49 ± 5.77 | 15 | 3.45 ± 0.06 | ns |
| Actual fat yield | BS | 1 | 78 | 107.4 ± 4.40 | 86 | 122.4 ± 4.20 | * |
| | BS | 2 | 55 | 127.9 ± 4.70 | 58 | 124.60 ± 4.90 | ns |
| | BS | 3 | 27 | 141.2 ± 4.98 | 29 | 134. 0 ± 4.70 | ns |
| | HF | 1 | 53 | 109.4 ± 5.30 | 41 | 117.2 ± 5.60 | ns |
| | HF | 2 | 38 | 135.2 ± 6.21 | 29 | 115.6 ± 7.29 | * |
| | HF | 3 | 23 | 125.5 ± 5.06 | 15 | 119.0 ± 5.88 | * |
| 305 days fat yield | BS | 1 | 78 | 99.2 ± 3.35 | 86 | 111.4 ± 3.23 | ** |
| | BS | 2 | 55 | 119.0 ± 3.70 | 58 | 116.7 ± 3.86 | ns |
| | BS | 3 | 27 | 128.4 ± 5.06 | 29 | 125.6 ± 4.83 | ns |
| | HF | 1 | 53 | 105.0 ±4.46 | 41 | 111.9 ± 7.78 | ns |
| | HF | 2 | 38 | 119.4 ± 3.27 | 29 | 107.1 ± 3.84 | + |
| | HF | 3 | 23 | 119.4 ± 3.86 | 15 | 112.6 ± 4.49 | * |

BS: Brown Swiss, HF: Holstein Friesain, S: Significance, ns: non-significant, +: Marginal Significance ($P < 0.10$)
*$P<0.05$, ** $P<0.01$,

**Table 5**
**Phenotypic correlation between average daily gain and age at first calving with milk yield traits**

| Traits | Breeds | ADG | | Traits | Breeds | AFC | |
|---|---|---|---|---|---|---|---|
| | | N= (BS:180,HF:102) | | | | N= (BS: 180, HF:102) | |
| | | Correlation | S | | | Correlation | S |
| Actual Milk Yield | BS | 0.05 | ns | Actual Milk Yield | BS | 0.139 | ns |
| | HF | 0.147 | ns | | HF | 0.076 | ns |
| 305-days milk yield | BS | 0.019 | ns | 305 days milk yield | BS | 0.177 | * |
| | HF | 0.160 | ns | | HF | 0.178 | ns |
| Lactation duration | BS | 0.142 | ns | Lactation duration | BS | 0.068 | ns |
| | HF | 0.199 | * | | HF | -0.080 | ns |
| Fat % | BS | 0.09 | ns | Fat % | BS | -0.204 | ** |
| | HF | 0.008 | ns | | HF | -0.068 | ns |
| Actual fat yield | BS | 0.026 | ns | Actual fat yield | BS | 0.031 | ns |
| | HF | 0.140 | ns | | HF | 0.094 | ns |
| 305-days fat yield | BS | 0.021 | ns | 305 days fat yield | BS | 0.075 | ns |
| | HF | 0.036 | ns | | HF | 0.132 | ns |

ADG: Average daily gain, AFC: Age at first calving, BS: Brown Swiss, HF: Holstein Friesain
S: Significance, ns:non-significant, *P<0.05, **P<0.01

**Table 6**
**Phenotypic correlations between average daily gain and age at first calving with reproduction traits**

| Traits | Irk | ADG | | Traits | Irk | AFC | |
|---|---|---|---|---|---|---|---|
| | | N= (BS: 127, HF: 74) | | | | N= (BS: 127, HF:74) | |
| | | Correlation | S | | | Correlation | S |
| Age at first calving | BS | -0.484 | ** | Calving interval | BS | -0.049 | ns |
| | HF | 0.003 | ns | | HF | -0.344 | ** |
| Calving interval | BS | 0.149 | ns | Days open | BS | -0.014 | ns |
| | HF | -0.103 | ns | | HF | -0.134 | ns |
| Days open | BS | 0.123 | ns | | | | |
| | HF | -0.106 | ns | | | | |

ADG: Average daily gain, AFC: Age at first calving, BS: Brown Swiss, HF: Holstein Friesain
S: Significance, ns:non-significant, *P<0.05, **P<0.01

same breed that displayed slower growth. Hoffman and Funk (1992) and Heinrichs (1993) stated that the most appropriate age for calving in this breed was the 24 month and the average daily live gain should be 767 g/day for the calving. On the other hand, Abeni et al. (2000) reported that the pre-pubertal daily live gain should be 700-800 g/day in large size breeds. Based on these suggestions, it appears that BS and HF heifers raised in this farm grow slower (475.0 ± 5.7 g/day for BS; 499.2 ± 6.9 g/day for HF) than the peculiar standards of their breeds. As a result of that, they calved much later than the usual age at first calving. The farm

where the study is carried out was located in an altitude of 1900 m from sea level, has a continental cold climate and applies semi-intensive dairy cattle husbandry. As a consequence of the adverse climatic conditions, it was revealed that BS and HF heifers could not complete their morphological and physiological development peculiar to their breeds. It was also observed that the BS heifers had a lower daily growth rate and calved about 2.5 months later (34.9 ± 0.4 mo vs. 32.4 ± 0.4 mo) than HF heifers.

The effect of daily gain on the first calving interval and the days open in first calving interval were not statistically significant (Table 2). Although the BS heifers in moderate group had a longer first calving interval (21.8 days) and higher number of days to open (12.1 days) than those in slow group, but the differences were not statistically significant.

The effect of the daily gain on the second calving interval was found to be significant ($P<0.05$) for two breeds. The second calving interval of BS and HF heifers in moderate group was longer than that of heifers in slow group. This difference (35.9 days in BS vs 72.6 days in HF heifers) were statistically significant ($P<0.05$). Bouska et al. (2007) reported that the first calving interval of HF heifers which grew rapidly in the first 14 months was significantly ($P<0.05$) longer (about 21 days) than those which had a slower growth. However, they found no significant difference between the groups concerning second calving interval.

The average daily gain from birth to 18 month age had no significant effect on the first lactation milk yield traits in two breeds (Table 3). But, several studies (Hoffman et al., 1996; Van Amburgh et al., 1998; Lammers et al., 1999; Radcliff et al., 2000) reported that the daily growth rate had a negative effect on the milk production of the first lactation. Although this mechanism is not completely known, Capuco et al. (1995) stated that the rapid growing in the pre-pubertal stages have been implicated in reduced mammary parenchyma development. In addition, Abeni et al. (2000) stated that this fast growth may reduce the total time for the mammary development. Serjsen and Pump (1997) pointed out that rapid growth in the prepubertal stages might reduce the milk production in the first lactation as it decreases the development of secretive tissues. However, parallel to our findings, there are also other studies (Pirlo et al., 1997; Waldo et al., 1998; Macdonald et al., 2005) which propose that the growth rate in the pre-pubertal stages has no effect on the lactation milk yield.

Except for third lactation duration, daily gain had no significant effect on the milk production traits in the second and third parities of BS heifers. The cows with moderate daily gain in third parity were milked 43 days ($P<0.01$) longer than animals in moderate group. HF heifers in slower group produced less 585 kg actual milk yield ($P<0.05$) and 324 kg 305-days milk yield ($P<0.05$) in the second parity. Although there was a similar tendency in the third parity, this difference was not statistically significant. Despite the increase in the milk production in the second and the third parities, there were some declines in the percentage of milk fat ($P<0.05$) in third parity. Macdonald et al. (2005) reported that the daily gain of HF cows had no effect on the milk production traits in the first, second and third parities. Bouska et al. (2007) stated that heifers with high daily gain among the same breed produced much more milk in the first lactation. However, there was no difference in the second lactation and they produced lower amount of milk in the third lactation. Gardner et al. (1977) determined that HF heifers with rapid daily gain produced much less milk in the first lactation, whereas there was no difference in the second and the third parities but they produced much more milk in the fourth parity.

It was observed that the daily growth rate in BS heifers from birth to 18 month did not have any impact on the milk production characteristics of the first, second and third parities. HF cows with lower daily gain had less actual and 305-days milk yield in second parity. However, the cows with daily gain above or below average had no systematic difference in terms of the milk production traits in the first, second and the third lactations.

The effects of the early or late ages at first calving on the first, second and the third lactation milk production traits are presented in Table 4. In both breed, heifers calved earlier produced lower ($P<0.05$) amount

of actual and 305-days milk yield. This result is consistent with previous studies (Gardner et al., 1977; Little and Kay, 1979; Hoffman et al., 1996) which report that early calving reduces the milk production in the first parity. The result could be explained by the fact that the early calving heifers have lower live weight compared to the late calving ones (Abeni et al., 2000).

Actual and 305-days milk fat yield of late calving BS heifers were higher ($P<0.05$) than these of early calving group. Contrary to the results of the present study, Abeni et al. (2000) found these values to be lower. However, calving age of HF did not caused any significant effects on the traits.

HF heifers calved earlier had a higher 305-days milk yield in second (102 kg) and third parities (211 kg), the differences observed between these two groups were statistically significant ($P<0.05$) (Table 4). Despite the increases in the milk yield along with advancing the parities, significant ($P<0.05$) increases of the actual fat yield and 305-days fat yield occurred in second and third lactations.

In BS heifers, the effects of early calving on the milk production traits of the second and the third lactations were not significant. On the other hand, HF heifers calved earlier has positive effects on the milk yield in second and third parities.

Generally, there were low and non-significant phenotypic correlations between daily gain and milk production traits (Table 5). Only in HF, correlation between daily gain and lactation length was positive and significant ($P<0.05$). The results indicated that heifers had daily gain above average between birth and 18 months of ages were milked in a longer period. In BS cows, age at first calving has a high ($P<0.05$) positive correlation ($r=0.177$) with 305-days milk yield, indicating that as the age at first calving increased, the 305-days milk yield went up. On the other hand in the same breed, age at first calving was negative ($r=-0.204$) and highly ($P<0.01$) related with percentage of milk fat. The results revealed that percentage of milk fat declined by increasing of the age at first calving.

Phenotypic correlation between average daily gain and age at first calving with some reproduction traits are presented in Table 6. The correlation between average daily gain and age at first calving was negative ($r=-0.484$) and significant ($P<0.01$) in BS cows. This result indicated that first calving age decreased with increasing daily gain. In HF cows, as the age first calving increased, the calving interval decreased significantly ($P<0.01$).

## Conclusion

Overall results suggested that the average daily gain from birth to 18 month age had no significant effect on the milk production traits in first and all parities for HF and BS cows respectively. However, HF and BS cows in moderate ADG group had numerically longer lactation duration than these in slow growth rate group. In both breeds, average actual and 305-days milk yields of the cows calved at early ages were significantly lower than these of cows in late group. Percentage of the milk fat was lessened by increasing the age at first calving.

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