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Phenotypic Trend of Lactation Milk of Iranian Holsteins in Yasuj

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Abstract: A total of 136,250 monthly test day milk records collected from 13,625 Iranian Holstein heifers in Yasuj (three times a day milking) calved between 1997 and 2007 and distributed over 264 herds were used to study the effect of some environmental factors influence lactation curve parameters as well as production characteristics. Wilmink's function ($Y_t = W_0 + W_1t + W_2e^{-0.05t}$) was fitted to individual lactation. Least squares analysis of variance indicated that the herd, year and month calving had a significant effect of all traits under consideration. Correlation analysis showed that the parameters W_0 had a negative and significant ($p \leq 0.05$) relationship with parameters W_1 and W_2, while it was positively significantly correlated with milk at peak time and 305 days milk yield. Simple linear regression analysis adjusted means of 305 days milk yield, days to reach peak yield as well as peak milk yield in the first year of calving also revealed that there was a phenotypic increase of 137.152, 0.535 and 0.434 kg year^{-1}, respectively.

Key words: Phenotypic trend, Iranian holstein, lactation milk, linear regression analysis, Wilmink's function

INTRODUCTION

Recently, there has been considerable interest in using test day models to analysis individual test day records for the genetic evaluation of dairy cows as a replacement for the traditional use of estimating accumulated 305 days lactation yields in a lactation model. Canada, for example, has officially adopted and implemented a random regression test day model in 1999 to replace the lactation model (Schaeffer *et al*., 2000). In a practical situation, as genetic evaluation of dairy cattle is undertaken using monthly test day records in a test day model, parametric models like Wilmink (1987)'s or polynomial regression functions (Jamrozik and Schaeffer, 1997; Jamrozik *et al*., 1997; Kaya *et al*., 2003) or Orthogonal Legendry Polynomials in covariance function (Druet *et al*., 2003) could be used in the model (as fixed and random regressions) to take account of the shape of the lactation curve for individual cows at the genetic level. However, particular attention should be given to the number of monthly test day records available for each cow. This is due to the fact that the accuracy of estimation of genetic parameters and prediction of breeding values is affected to a great extent by the number of test day records available for each cow during lactation. It has been well documented that the lactation curve is influenced by environmental factors such as the herd, year of calving, parity, age of calving and season of calving (Congleton and Everrett, 1980; Grossman *et al*., 1986; Tekerli *et al*., 2000).

The main objective of the present research was to analysis some environmental factors in flouncing lactation curve parameters for Iranian Holstein heifers as well as their production characteristics by fitting Wilmink (1987)'s function to monthly test day milk yields. Furthermore, adjusted phenotypic trends for all the traits under consideration will also be obtained.

MATERIALS AND METHODS

An initial data set consisting of 457,576 first lactation monthly test day milk records were obtained from the Animal Breeding Centre of Bonyad-e-Mostazafan-e-Iran in Yasuj. The data was subsequently edited on the basis of the number of monthly test days (during the lactation period) and interval between consecutive test days for individual cows (three times a day milking). The interval between consecutive test days was set up to be a maximum of 60 days. Furthermore, from a computational point of view, only cows with a complete first lactation, which had 10 monthly test day records were utilized to obtain a better estimation of the lactation curve parameters for individual cows. The final data set consisted of 136,250 monthly test day milk yields belonging to 13,625 first lactations of Iranian Holstein heifers from 264 herds that calved from 1997-2007. Some descriptive statistics of data are presented in Table 1. To describe the lactation curve and associated

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Table 1: Descriptive statistics of the data set

Month of lactation	Days in milk Mean	SD	CV (%)	Daily milk yield (kg) Mean	SD	CV (%)
1	13.68	6.64	48.53	23.53	5.50	23.37
2	44.15	6.53	14.79	26.38	5.02	19.02
3	74.41	6.77	9.09	29.28	5.27	17.99
4	104.87	6.55	6.24	28.87	5.40	18.70
5	135.18	6.78	5.01	27.88	5.46	19.58
6	165.66	6.58	3.97	26.75	5.52	20.63
7	195.95	6.79	3.46	25.57	5.52	21.58
8	226.43	6.60	2.91	24.41	5.43	22.24
9	256.72	6.84	2.66	23.14	5.28	22.81
10	287.14	6.67	2.32	21.69	5.29	24.38

production characteristics, Wilmink (1987)'s function was applied in this study. The function is as follows:

$$Y_t = W_0+W_1t+W_2 (E_{xp})^{-0.05t} \quad (1)$$

Where:

- t = Days in milk
- y_t = Milk yield in kg at day t
- W_0 = Associated with the level of production
- W_1 = Associated with production decrease after peak yield
- W_2 = Associated with production in crease towards peak yield

The parameters of Wilminks function (W_0, W_1 and W_2) were estimated for individual lactations by applying the REG procedure of the SAS software (SAS Institute, 2005). Based on the estimated lactation curve parameters, some production characteristics including Peak Time (PT), Peak Milk Yield (PM), Milk yields at days 60 (M60) and 280 (M280) and total 305-day Milk Yield (TM305) were also calculated for individual cows as follows:

$$PT = -20 (\ln 20\hat{W}_1/\hat{W}_2) \quad (2)$$

$$PM = \hat{W}_0 + \hat{W}_1 (-20 (\ln 20\hat{W}_1/\hat{W}_2)) + \hat{W}_2^{e-0.05 (-20 (\ln 20\hat{W}_1/\hat{W}_2))} \quad (3)$$

$$M60 = \hat{W}_0 + \hat{W}_1 (60) + \hat{W}_2^{e-0.05 (60)} \quad (4)$$

$$M280 = \hat{W}_0 + \hat{W}_1 (280) + \hat{W}_2^{e-0.05 (280)} \quad (5)$$

$$TM305 = 305 \hat{W}_0 + 46665 \hat{W}_1 + 19.50416 \hat{W}_2 \quad (6)$$

In order to analyse the effects of environ-mental factors including the herd, year of calving, month of calving and age at first calving, a fixed linear model was fitted on estimated lactation curve parameters and production characteristics. Due to the highly unbalanced data, no attempt was made to fetal two and three way interactions into the model. Least squares analysis of variance were undertaken day the use of the GLM procedure (General Linear Model) of the SAS software (SAS Institute, 2005). The linear model was as follows:

$$Y_{ijk} = \mu + (\text{herd})_i + (\text{year})_j + (\text{month})_k + \sum^2_{R-1} \beta_R * [(\text{age}_{ijk})^R-(\alpha^R)] + e_{ijk} \quad (7)$$

Where:

- Y_{ijk} = The value of the considered trait (W_0, W_1, W_2, PT, PM, M60, M280 and TM305) affected by the ith herd, jth year of calving, kth month of calving and co variable of age at calving
- μ = The overall mean for each trait
- herd_i = The fixed effect of the jth herd (I = 1-264)
- year_j = The fixed effect of the jth year of calving (j = 1-11)
- month_k = The fixed effect of the kth month of calving (k = 1-12)
- β_R = Linear and q quadratic regression coefficients of age_{ijk}
- e_{ijk} = Random effect of residual with expectation and variance equal to 0 and $\delta^2 e$, respectively

Least squares means of year and month of calving for individual trait were obtained along with analysis of variance using LSMEANS option.

Pearson correlation coefficients (r) among eight traits were calculated using SAS software (SAS Institute, 2005). Tests-of significance were also performed under H_0: p = 0.

RESULTS AND DISCUSSION

Overall means of W_0, W_1, W_2, PM, M60, M280, TM305 and PT were 31.67, -0.032, -15.880, 29.13, 28.93, 22.60, 7839 kg and 64.94 days, respectively. The results of least squares analysis of variance for all eight traits are presented in Table 2. As can be shown, all analyzed traits were significantly affected by the herd, year and month of calving. However, the year of calving affected parameter W_1 only on a probability level of $p \le 0.05$. The linear effect of age at first calving significantly influenced all traits except parameter W_2, which is associated with in- creased production towards peak yield. The quadratic order of first calving age in the model had no significant effect on parameter W_2 and M280, while it was significant for the other traits.

The results also revealed that the herd effect had the greatest contribution from the total sum of squares. In contrast, the age at first calving, when fitted as a quadratic effect had the lowest proportion of total variation in all traits. Hence, the herd and age at first calving are considered to be the most and the least important factors, respectively, influencing lactation curve parameters and production characteristics.

Table 2: Sum of squares values resulting from least squares analysis of variance of lactation curve parameters as well as production characteristics for the environmental factors fitted in the GLM

	Source of variation				
Traits	Herd	Year	Month	Age (Linear)	Age (Quadratic)
W_0^a	86,670***	11,549***	6098***	718***	399***
W_1^a	0.3168***	0.0077*	0.0883***	0.0037**	0.0020*
W_2^a	98,164***	3965***	18,715***	186NS	77NS
PT^b	26,5250***	20,913***	41,052***	2779**	2406*
PMc^d	73,928***	11,623***	3984***	513***	286***
$M60d^d$	73,129***	11,464***	3998***	505***	284***
$M280^e$	71,566***	14,463***	5596***	94**	55NS
$TM305^f$	6,085,289,482***	1,133,076,573***	31,1008,426***	25,662,663***	14,709,182***

[a]Parameters of Wilmink (1987)'s function; [b]Peak time; [c]Peak milk; [d]Milk yield at day 60; [e]Milk yield at day 280 and [f]Milk yield for 305 days. NS: Non Significant

Table 3: Least squares means for month of calving

Months of	Traits							
calving	W_0^a	W_1^a	W_2^a	PT^b	PM^c	$M60^d$	$M280^e$	$TM305^f$
Jan.	30.45	-0.0324	-14.616	62.20	27.94	27.78	21.37	7490
Feb.	30.47	-0.0342	-15.086	61.41	27.84	27.67	20.90	4704
Mar.	30.67	-0.0354	-14.463	61.02	28.00	27.83	20.77	7423
Apr.	29.87	-0.0349	-13.585	59.36	27.25	27.10	20.10	7217
May	29.30	-0.0329	-12.895	59.99	26.84	26.68	20.09	7150
Jun.	29.23	-0.0324	-11.881	58.99	26.85	26.70	20.17	7175
Jul.	29.13	-0.0317	-12.025	60.02	26.82	26.63	20.25	7171
Aug.	28.49	-0.0281	-11.475	61.97	26.41	26.23	20.62	7155
Sep.	28.93	-0.0271	-11.826	63.27	26.90	26.72	21.36	7333
Oct.	29.58	-0.0279	-13.060	64.53	27.43	27.25	21.76	7465
Nov.	30.27	-0.0298	-13.527	63.61	27.99	27.81	21.93	7581
Dec.	30.49	-0.0314	-14.636	63.98	28.04	27.87	21.70	7549

Table 4: Pearson product moment correlations (r) between lactaion curve parameters and production characteristics

Traits	W_0^a	W_1^a	W_2^a	PT^b	PM^c	$M60^d$	$M280^e$	$TM305^f$
W_0^a	1.000	-0.556***	-0.465***	-0.070***	0.975***	0.976***	0.519***	0.830***
W_1^a		1.000	0.318***	0.525***	-0.371***	-0.376***	0.422***	-0.008NS
W_2^a			1.000	-0.430***	-0.375***	-0.365***	-0.179***	0.242***
PT^b				1.000	0.011NS	0.001NS	0.464***	0.194***
PM^c					1.000	0.999***	0.682***	0.930***
$M60^d$		(Symmetric)				1.000	0.678***	0.929***
$M280^e$							1.000	0.897***
$TM305^f$								1.000

[a]Parameters of Wilmink's function; [b]Peak time; [c]Peak milk; [d]Milk yield at day 60 ; [e]Milk yield at day 280 and [f]Milk yield for 305 days

Least squares means of month of calving for individual traits are presented in Table 3. For month of calving, the lowest W_0 (level of production) occurred for cows calved between April to October. The highest levels of production were found for cows calved between November-March. These results revealed that cows calved from August to November had the lowest rate of production decrease after peak yield (W_1). In contrast, cows calved between February to March had the highest rate of production decrease after peak yield and are considered to be more persistent. Parameter W_2, which is associated with production increase to wards peak yield, was found to be lower for cows calved during May to September than that of cows calved during October to April. The results showed that cows calved from January to August reached earlier peak yield during lactation. On the other hand, The highest number of days needed to attain peak production was found for cows calved in October, where by cows had a lower rate of decrease of production after peak yield towards the end of the lactation course. Peak Milk yield (PM) at each month of calving was generally greater than milk yield at 60 days of lactation (M60) and both the same changes during different months of calving such that cows calved during May to September were found to have lower panda M60 than that of cows calved during October to April. The results also indicated that cows calved in spring and summer (from April to September) produced lower Total Lactation Milk Yield (TM305) than that of cows calving during autumn and winter seasons. Pearson product moment correlation coefficients among the lactation curve parameters and production characteristics are given in Table 4. The results showed that parameter W_0, which is associated with the level of production was negatively correlated with W_1, W_2 and peak time, while it was positively correlated with peak yield milk yields at days 60 and 280 as well as total lactation milk yield. Negative correlations were found between the parameter related to the production increase before peak yield and PT, PM, M60, M280 and TM305.

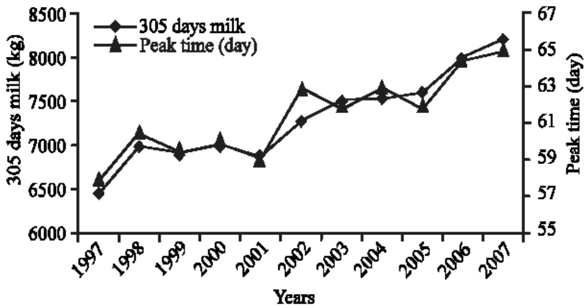

Fig. 1: Phenotypic trends for 350 days milk yield (+137.152 kg $year^{-1}$) and peak time (+0.535 days $year^{-1}$) in Iranian Holstien heifers over 11 years of calving

The parameter W_1 had negative correlations with peak yield and milk yield at day 60, while it was positively correlated with W_2, peak time and milk yield at day 280.

No significant ($p>0.05$) correlation was obtained between the lactation parameter W_1 and total lactation milk yields. Peak time had positive and significant ($p\leq 0.01$) correlations with milk yield at day 280 and total lactation milk yield.

The correlation analysis revealed that milk yield at peak time had positive correlation with M280 and very high positive correlations with M60 and TM305. Milk yields at days 60 and 280 were also strongly positive correlated with total lactation milk yield.

On the basis of adjusted means for the year of calving, phenotypic trends for each trait were calculated using simple linear regression analysis. The results obtained from the regression analysis showed that total lactation milk yield, an annual increase of 137.152 kg ($p\leq 0.01$) during 1997-2007. At the same time, the number of days needed to reach peak yield also showed a significant ($p\leq 0.01$) annual increase of 0.535 days (Fig. 1). Phenotypic trends calculated for W_0, W_1, W_2, PM, M60, M280 were 0.428 kg ($p\leq 0.01$), 0.0002 ($p<0.05$), -0.157, 0.434, 0.433 and 0.486 kg ($p\leq 0.01$), respectively.

CONCLUSION

Wilmink (1987)'s function was used to evaluate the effects of some environmental factors affecting lactation curve parameters as well as some production characteristics of Iranian Holstein cows at first lactation. Thus far, some research has been carried out to analyze phenotypic and genetic aspects of the lactation curve using Wilmink's function. In accordance with the finding of Dedkova and Nemcova (2003), the year and month of calving had significant effects on most of the traits under consideration; the herd also affected all traits, significantly with regard to the continuous distribution of the calving, age of this environmental factor was also fitted in the GLM as a covariate (as applied by Visscher *et al*., 1991; Visscher and Thompson, 1992; Strabel and Szwaczkowski, 2001; Ojango and Pollott, 2001) and had a significant effect on all traits except the parameter W_2. The results obtained from a correlation analysis of the traits in the present study indicated that milk yield at the peak time is strongly correlated at the phenotypic level with total lactation milk yield. However, genetic study will have to be undertaken to see how closely these traits are genetically correlated as well as the magnitude of their heritability. A large positive genetic correlation between 305 days and peak milk yield was also found in most studies (Ferris *et al*., 1985: Rekaya *et al*., 2000). Peak time was also correlated with 305 days milk yield. Therefore, direct selection for total lactation yield would be expected to result in lactations with a higher peak production and later peak time in Iranian Holstein heifers.

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