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ORIGINAL ARTICLE

Genetic parameters of test day Milk yields of Iranian Holstein cows

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ABSTRACT

Test-day milk yields of first lactation in Iranian Holstein cows were used for Genetic parameter at different test day. The data included 85891 Iranian Holstein cows from 714 herds that first calved between 1991 and 2013. The genetic evaluation of dairy sire and cows for production traits has been based on the analysis of 305-day lactation yield .A completed 305-day lactation yield is based on 10 test day (TD) yields are usually taken approximately at monthly intervals. Therefore data were divided into 10 subsets based on the number of days in milk yield.Test day milk yields TD1 to TD10 and 305-day milk yield (MP305) were the traits studied. These traits were adjusted for several environmental effects: class of cow age at calving, interval from calving to first test day, and herd-year-season. Restricted maximum likelihood estimates of (co)variance components were obtained from one and two-traits analysis under an animal model.Estimates of heritability's for TD ranged from 0.12 to 0.24. The highest values were found in the second half of lactation (TD5 to TD7). Heritability estimate for MP305 was 0.24. Genetic correlations between individual test days and MP305 ranged from 0.33 to 0.97 Results suggested that test day milk yields, mainly in mid-lactation, can be used instead of 305-day milk yield in genetic evaluations, because estimates of these two-trait heritability's are nearly alike. Moreover, early selection can reduce generation intervals.
Key Words: Test-day milk yield, genetic parameter, Iranian Holstein

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INTRODUCTION

The genetic evaluation of dairy sire and cows for production traits has been based on the analysis of 305-day lactation yield. A completed 305-day lactation yield is based on 7 to 10 test day (TD) yields are usually taken approximately at monthly intervals. TD yields are affected by factors such as breed, herd management and management group within a herd, regions of country, days of the calving year, age at calving and test, pregnancy status, days in milk and milking times per day [1,2]. The effects of environmental factors on each TD yield have been averaged together for the lactation yield. Averaging would be appropriate if the factors were the same for each TD and represented random environmental variation, but many of these factors for a cow vary from one TD to the next and it would be difficult to model for 305-day yields [1, 2]. In recent years use of test day records (TD) be attention for genetic evaluation of dairy cattle for milk production instead to 305 days record (MP305).there are several reasons for the use of TD records, in this method could have done evaluation and selection of genetic in shorter time and increasing response to genetic selection and reduce generation interval. On the other hand no need for extension.no need for normal length of lactation period and improved accuracy of evaluation for production traits [1,3], for use of test day records for genetic evaluation needs to genetic parameter in different test day (TD1 to TD10) and genetic correlation with 305-day throughout a lactation. Many authors have estimated genetic parameters for different test day that in most of them heritability estimates were highest for mid-lactation and genetic correlations between TD record from mid-lactation and 305-day were high [4,5,6].The present study aims to estimate components of variance and covariance for test day milk yields in first lactation of Iranian Holstein under a TD model. Therefore additive genetic variance, environmental variance and heritability of test day milk yields where estimated. And also Genetic and phenotypic correlations between TD records and between TD and 305-day records was examined.

MATERIALS AND METHODS

Data consisted of TD and 305-day milk yield records of Iranian Holstein cows that calved at first between 1991 and 2013 and were obtained by Animal breeding center of Iran. Only first lactation records from cows aged between 1.5 and 3.5 years at calving were considered in this study.Test day milk yields, recorded at approximately monthly intervals throughout lactation from TD1 to TD10, and milk yields up to 305-days (MP305) were the traits under analysis.The first interval in days for the first test was defined as date of recorded test day minus date of calving.Records with a first interval less than four or greater than 45 days were eliminated for further analysis. Because test days do not always follow a regular interval of 30 days ,interval classes of 30 days were created to make the 10 test days uniform. Test day records after 305 days were eliminated. Lactations with at least two test day records were used, or heritability's and correlations for the first two tests were taken from the analysis of records of cows with at least two valid tests [7]. Lactation records were discarded when the sire had less than five daughters, or when all the daughters were in the same herd. Finally, a data set of 85,891 test day records of first lactations of Holstein cows, sired by 714 bulls, was used for further analysis. Two calving seasons were considered: the rainy season, October through March, and the dry season, April through September. Herd-year-season subclasses with at least four observations were used in the analysis. Age at calving was split into five classes (1.5 to 2.1; 2.2 to 2.4; 2.5 to 2.7; 2.8 to 3.1, and 3.2 to 3.5 years). Four classes were defined for the calving to first test day interval (from day 4 to day 14; 15 to 24; 25 to 35, and 36 to 45). Summary of the data is given in Table1.

Table1 - The data set structure for the analysis of test day milk yields (TD1-TD10) in first lactations of Holstein cows.*

	TD1	TD2	TD3	TD4	TD5	TD6	TD7	TD8	TD9	TD10	MP305
Number of records	85428	86441	85428	84529	86411	85421	85129	85398	85734	85629	85891
Number of sires	720	720	720	720	720	720	720	720	716	714	714
Herd-year-season subclasses	718	714	716	719	719	713	713	715	712	712	717
Class of age at calving	5	5	5	5	5	5	5	5	5	5	5
Class of calving to first test day interval	3	4	4	4	4	4	4	4	4	4	4
Number of herds	667	674	660	6 61	664	660	661	660	657	652	652

* TD1 was taken from the first 30 days of lactation, TD2 from the second, etc.

Heritability for single TD and 305-day yield estimated under unvaried model. The following model was used for TD records:

$$y_{ijkl} = HYST_i + M_j + \sum_{n=1}^{2} b_n DIM_{ijkl}^{n} + \sum_{i=1}^{2} b_{(n+1)} AGE_{ijkl}^{n} + b_5 HF_{ijkl} + e_{ijkl}$$

Where,

y_{ijkl}=TD record on milk yield, $HYST_i$=fixed effect of herd-year-season of test. Season was defined as spring, summer, autumn and winter, M_j=fixed effect of milking times (j = 1, 2), DIM= fixed covariate of days in milk at test, AGE= fixed covariate of age of calving, HF = fixed covariate of proportion of Holstein blood in the animal,The model for the analysis of 305-day yield was:

$$y_{ijkl} = HYS_i + a_j + \sum_{n=1}^{2} b_n AGE_{ijkl}^{n} + b_3 HF_{ijk} + e_{ijk}$$

where HYS was fixed effect of herd-year-season of calving and covariates were similar to single TD model . Variance components were estimated with restricted maximum likelihood (REML) method using REML 3.1 software [7] .Animal model were applied throughout the analysis. For estimation of genetic and phenotypic covariance between TD records and between individual TD and 305-day records, a multiple trait model was used. To enable the computation to be made with a multiple trait model data were reduced. Thus only cows with the first 10 TD records had remained and cows with lower than 10 tests were excluded from data file. Reduced data file consisted of 85,891 TD records for milk yield To simplify the computation, 2-traits models were used.

Preliminary analysis on data set from Table1 indicated that there was no significant effect of class of calving to first test day interval on test day milk yields from the third test day on, so that this effect was considered only for TD1 and TD2. Convergence criterion was defined for simplex variance below 10-9.

RESULTS

Phenotypic means, standard deviation and coefficient of variation for TD and complete lactation records are presented in Table 2. On average first test was taken 20 days after calving with subsequent test taken at average intervals of approximately 30 days. The peak milk yield occurred at TD3 and subsequently, yield decreased as lactation progressed .The coefficient of variation (CV%) of milk yield increased as lactation progressed. Additive genetic and residual variance components and heritability estimates for TD and complete lactation records of milk yield are presented in Table3.

Table2 –number of observations (N), standard deviations (SD) (kg), phenotypic means ($\bar{x}$) (kg), and coefficient of variation (CV%) of test day milk yields (TD1 to TD10) of first lactation Holstein cows.

	TD1	TD2	TD3	TD4	TD5	TD6	TD7	TD8	TD9	TD10	MP305
N	85428	86,441	85,428	84,529	86,411	85,421	85,129	85,398	85,734	85,629	85,891
$\bar{x}$	25.12	27.93	28.18	26.89	26.21	25.14	24.23	22.45	21.63	16.32	7293.48
SD	6.35	6.61	6.63	6.74	6.85	6.91	6.82	6.94	6.14	4.31	1371.18
CV%	25.28	23.67	23.53	25.07	26.14	27.49	28.15	30.91	28.39	26.43	18.80

Table 3 –Estimated additive genetic variance, environmental variance and Heritability (h^2) and standard error of test day milk yields

	TD1	TD2	TD3	TD4	TD5	TD6	TD7	TD8	TD9	TD10	MP305
V_A	4.22	4.16	4.10	4.87	4.91	5.24	5.16	5.72	5.65	4.58	34531787
V_E	31.61	24.43	22.28	21.11	21.16	21.16	20.12	21.54	21.08	21.13	112149583
h^2	0.12	0.15	0.16	0.19	0.19	0.20	0.20	0.21	0.21	0.18	0.24
SE(h^2)	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02

Additive genetic variance was increased as lactation progressed for milk yield and was highest in mid-lactation (i.e. TD6-TD9) and subsequently decreased at the end of lactation. Residual variance was decreased steadily and was lowest at the end of lactation. Heritability estimates for TD records were highest in second half of lactation and ranged from 0.12 to 0.21 for milk TD. The highest and the most stable heritability estimates from one TD to next appeared in the interval 6th-9thTD.Heritability estimates for 305-day and milk yield were 0.24. In all cases the heritability for TD records was lower than the corresponding complete lactation. For milk yield the heritability estimates have slightly declined from TD9 to TD10.However 305-day heritability estimate was slightly higher for milk yield. Genetic and phenotypic correlations between TD records and between TD and 305-day records are presented in Table 4.

Table4.Genetic(above diagonal) and phonotypic(below diagonal) correlations between TD and 305 day milk yield

	TD1	TD2	TD3	TD4	TD5	TD6	TD7	TD8	TD9	TD10	MP305
TD1		0.88	0.81	0.68	0.67	0.67	0.67	0.58	0.57	0.44	0.58
TD2	0.50		0.93	0.85	0.82	0.80	0.78	0.78	0.70	0.59	0.60
TD3	0.42	0.58		0.96	0.95	0.95	0.86	0.88	0.88	0.79	0.81
TD4	0.38	0.52	0.61		0.97	0.95	0.94	0.91	0.86	0.75	0.76
TD5	0.33	0.58	0.57	0.60		0.97	0.97	0.93	0.93	0.81	0.76
TD6	0.33	0.45	0.53	0.60	0.67		0.97	0.95	0.94	0.82	0.75
TD7	0.32	0.43	0.52	0.56	0.62	0.71		0.97	0.97	0.90	0.84
TD8	0.31	0.45	0.49	0.52	0.58	0.66	0.71		0.97	0.91	0.81
TD9	0.30	0.38	0.45	0.49	0.54	0.61	0.65	0.71		0.96	0.35
TD10	0.23	0.33	0.40	0.43	0.48	0.54	0.56	0.63	0.70		0.33
MP305	0.57	0.52	0.59	0.75	0.77	0.79	0.72	0.71	0.57	0.40	

The genetic correlations between individual TD records varied from 0.33 to 0.97. Genetic correlations between individual TD records were high and decreased as the distance between tests increased but always were positive. As lactation progressed genetic correlations between tests were increased but for the last month this correlation dropped .The genetic correlations between TD and 305-day records for milk yield were high at mid-lactation (for TD3 to TD7). The first two and the last two TD yields had lower correlations with complete lactation yield. Genetic correlations between individual TD records and 305-day record were always more than 0.33. Phenotypic correlations followed a similar pattern but were lower than the corresponding genetic correlations.

DISCUSSION

In this research heritability estimates increased as lactation progressed and were highest in second half of lactation. This pattern is in agreement with some reported results [6,8 and 9].Heritability estimates in mid-lactation were high and were in agreement with other studies. Generally in this study heritability estimates were lower than previous estimates on Iranian Holstein cows [10 and 11]. There are several factors that might influence level of heritability estimates. Among the many reasons which cause the differences in heritability estimates are different models and different ways for computing 305-day yield and different yield are defined. In earlier works on Iranian Holstein, random regression models were used for estimation of genetic parameters [10]. Usually in random regression models heritability is higher than ordinary TD models By using two different random regression sub-models which described individual lactation curves showed that both random regression models gave higher estimates of heritability than that of multiple trait models [2].
Heritability estimates in mid-lactation were high and were in agreement with other studies. Followed trends in the literature, with higher values found in the second half of lactation, between TD5 and TD7 [6, 7 and 12]. In most reports, estimates were similar to heritability for MP305. These published results suggested that test day records for mid-lactation could be used instead of MP305 in genetic evaluations of dairy animals, but in none of the studies mentioned the estimates of heritability exceed those obtained for MP305. This early selection can reduce generation interval.In other reports for TD9 and TD10, heritability's were lower than those presented [7, 8 and 13]. Considerable differences in heritability estimates are found in the literature, due to differences in populations, different methods of analysis and, especially, how a trait is defined.
Genetic correlations between consecutive TD records were high and decreased as distance between them increased. All correlation values were positive for milk yield varied from 0.33 to 0.97. Also, higher values were found in mid-lactation. However, other reports [12, 14, and 15] have found significantly lower values, with genetic correlations between TD1 and MP305 and between TD10 and MP305 equal to 1.0. Moreover, when MTDFREML is used in the estimation of genetic correlations, there is a tendency for the estimates to reach +1 or -1, and the convergence to reach alocal maximum. This may indicate the need for a larger data set to obtain better estimates [14].The first TD yield often sampled only a few days after calving and is less reliable measurement than other later TD yields. First TD affected by many environmental factors such as feeding before calving. This was indicated by larger variance at the beginning of the lactation. As a final conclusion, due to lower additive genetic variance and higher residual variance, the heritability at the beginning of lactation (TD1,TD2 and TD3) were lower than other records. Prediction of lactation yield from TD records is a function of their heritability and genetic correlations with complete lactation yield. Therefore it may not be sufficiently accurate to predict the complete lactation from earlier tests (TD1, TD2 and TD3) due to low heritability and genetic correlations. The high estimated heritability of TD yields and their genetic correlations with 305day yields during TD4 to TD7 that TD records especially in mid-lactation may be used for genetic evaluation instead of 305-day yield. This study has shown that genetic correlations be-tween test day milk yields and 305-day milk yield are high and positive, indicating that test day milk yields could be utilized in place of MP305 in genetic evaluations of dairy cattle's. The highest estimates of heritability in mid-lactation suggested that these test day yields (M4-M7) could be used as the selection criteria, leading to a reduction in generation interval.

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