International Journal of Advanced Biotechnology and Research (IJBR)
ISSN 0976-2612, Online ISSN 2278–599X,
Vol-7, Special Issue4-May, 2016, pp87-92
http://www.bipublication.com

Research Article

The study of productive and reproductive traits of first lactation in arid and semi-arid climate Holstein dairy cows of Iran

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ABSTRACT:

This research was carried out to study of productive and reproductive traits (milk (Milk), fat yield and percentage (Fat and FatP), protein yield and percentage (Pro and ProP), lactation length (LL), dry period (DP), age at first calving (AFC) and calving interval (CI)) of Holstein dairy cows in arid and semi aridclimate of Iran. Data were collected of 4805 and 58781 first lactation Iranian Holstein dairy cows in arid and semi-arid climate, respectively during 1996 to 2009 by the Animal Breeding Center of Iran. Variance components were estimated by restricted maximum likelihood method using DMU package. The estimated heritabilities in arid and semi-arid climate were 0.23, 0.27, 0.39, 0.28, 0.41, 0.04, 0.006, 0.23 and 0.04 of production and reproductive traits (Milk, Fat and FatP, Pro and ProP, LL, DP, AFC and CI), respectively and 0.21, 0.18, 0.08, 0.11, 0.34, 0.03, 0.02, 0.10 and 0.05, respectively. The current result showed least square mean of traits in semi-arid climate was higher than arid climate for all traits and it can be due to better management practices however for CI trait should be less($P<0.05$).

Key words: productive, reproductive, arid and semi-arid climate, Holstein

INTRODUCTION:

Knowledge of genetic and phenotypic parameters is required for planning efficient breeding programs in animal husbandry. One of these parameters is heritability that explains the extent to which observed differences between individuals are associated with additive genetic variance (the variance of the breeding values). With knowledge of this parameter, animal geneticists can determine whether or not a particular trait can be improved by selection, by improvement of management practices, or both. The second is defined as the correlations between two traits or two breeding values of traits (Roman, Wilcox and Martin, 2000). Estimates of genetic parameters for traits of economic importance in dairy cattle are necessary for implementing efficient breeding programs. Accurate heritability and correlation estimates are required to predict expected selection response and to obtain predicted breeding values using mixed model (BLUP) procedures. Traits related to milk, fat, and protein production, conformation, length of productive life, reproduction, workability, and health are included in breeding programs of dairy cattle in many countries (Mark, 2004; VanRaden, 2004) to maximize improvement of a breeding goal involving traits related to income and costs (e.g., Dekkers and Gibson, 1998). Extreme or rapid changes in environmental conditions can often be detrimental to cattle performance and well-being (Webster, 1973; Hahn, 1995). However, if climatic changes are not too abrupt, cattle can buffer effects of, and adapt to, changing environmental conditions through physiological and metabolic processes (Danesh Mesgaran et al. 2008). This problem in countries like Iran with more climate diversity is more considered. Iran situates in the southern half of geographic crown of temperate zone, between northern latitudes of 25 to 30°C and 39 to 47 and eastern lengths of 44 to 55 and 18 to 63 of the Greenwich meridian. Most of its regions are arid and semi-arid areas and its average annual rainfall is less than 250 mm. The weather coefficient of variation is 70%; therefore, the variety of its climate is large (Savar Sofla et al. 2011). The objective this study was investigation of productive and reproductive traits of first lactation in arid and semi arid climate Holstein dairy of Iran.

MATERIALS AND METHODS:

In this study, first lactation 305 days some productive and reproductive traits (milk (Milk), fat yield and percentage (Fat and FatP), protein yield and percentage (Pro and ProP), lactation length (LL), dry period (DP), age at first calving (AFC) and calving interval (CI)) from 63586 Holstein cows were used. The data was collected by the Livestock Breeding Center of Iran from 1996 to 2009. Information regarding to the pedigree file which is used in the study is presented in Table 1. Only records of cows with calving age between 18 to 36 months, calving interval between 300 to 600 days, were included and animals without records, sire or dam were removed. The data was edited by *Foxpro2*.6 Software.

Table 1: Summary of Pedigree and herd and herd-year season of calving (HYS) number in this study

Climate	Arid	Semi arid
Number of Records	4805	58781
Number animal of pedigree	9728	97254
Number of dam	4577	48870
Number of sire	716	2471
Number of Herd-Year-Season	673	7453
Number of Herd	70	593

Descriptive statistic (Number of records (No.records), standard deviation (SD), Mean, Coefficient of variation (CV), Maximum (Max), Minimum (Min) for productive and reproductive traits was showed in Table 2 and 3.

Table 2: Descriptive statistic for traits in arid climate

Trait	No. records	SD	Mean	CV	Min	Max
Milk (kg)	4805	7269	1307	17.98	1671	10914
Fat (kg)	4805	234	55	23.50	57	463
FatP(%)	4805	3.23	0.5	15.48	1.68	7.13
Pro (kg)	4805	220	38	17.27	66	382
ProP(%)	4805	3.04	0.23	7.57	2.13	4.83
LL (day)	4805	302	46	15.23	167	499
DP (day)	4805	66	23	34.85	15	150
AFC (month)	4805	26	2.7	10.38	20	39
CI (day)	4805	367	46	12.53	300	581

Table 3: Descriptive statistic for traits in semi arid climate

	No. records	SD	Mean	CV	Min	Max
Milk (kg)	58781	7152	1208	5.92	1604	12061
Fat (kg)	58781	235	48	4.90	48	522
FatP(%)	58781	3.30	0.5	6.60	1.4	6.3
Pro (kg)	58781	223	37	6.03	62	394

ProP(%)	58781	3.13	0.26	12.04	1.8	6.2
LL (day)	58781	309	48	6.44	161	500
DP (day)	58781	68	21	3.24	15	150
AFC (month)	58781	26	2.6	10.00	20	40

The effect of environmental factors on productive and reproductive traits was investigated by analysis of variance (lme4 package –R software) with the following model:

$$y_{ijklm} = \mu + herd_i + year_j + sea_k + Climate_l + HYS_m$$

$$+ b_1(HF - \overline{HF}) + b_2(AGE - \overline{AGE}) + e_{ijklm}$$

where y_{ijklm} is daily milk yield of nth animal affected by ith herd, jth calving year (year), kth season (sea) of calving, lst Climate, mth hys (random effect herd-year and season of calving), b_1 and b_2 are the linear regression coefficient of Holstein gene percent (HF) and age at first calving (AGE) (covariate), $\overline{HF}$ is mean HF, $\overline{AGE}$ is mean (AGE) e_{ij} is the random effect of residuals and μ is the overall mean.

Variance components were estimated via restricted maximum likelihood (REML) method in a univariate animal model using DMU package (Madsen and Jensen, 2007):

$$y_{ij} = \mu + HYS_i + b_1(HF - \overline{HF}) + b_2(AGE - \overline{AGE}) + a_j + e_{ij}$$

where y_{ij} y is daily milk yield or days open of jth animal (aj is random effect of animal) affected by ith herd-year and season of calving , b_1 and b_2 are the linear regression coefficient of Holstein gene percent (HF) and age at first calving (AGE) (covariate), e_{ij} is the random effect of residuals and μ is the overall mean.

In matrix notation this equation can be re-written as follows (Henderson, 1988): $\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{Zu}$

Where y is a column vector of observations for the traits (milk yield, days open)

X is a known design matrix relating elements of β to each y;

β is an unknown column vector of fixed effects of herd-year-season of calving, linear regression coefficients for age of calving and Holstein gene.

Z is a known design matrix of 0 and 1 relating elements of u to elements y;

u is an unknown column vector of random effect of additive genetic of animal (cows, dams and sires);

e is an unknown column vector of random effect of residuals.

Based on advanced De Martonne classification method (Dumitriu-Tatararu and Popescu, 1990) and available weather information of Iran Provinces, the data were divided into 5 climate groups (arid, semi dry, Mediterranean, humid and semi humid).

According to De Martonne's global classification, Provinces: Markazi, West and East Azarbayjan, Khozestan, Fars, Khorasan Razavi, Northen Khorasan, Kordestan, Hamedan, Charmahal Bakhtiari, Lorestan, Ghazvin and Tehran can be placed in the semi arid class and Semnan, Yazd, Southern Khorasan, Ghom, Sistan and Bluchestan, Kerman were in the arid class.

RESULT AND DISCUSSION:

Statistical summary of data for milk production in arid and semi arid climates of Iran is presented in Table 3 and 4. Coefficient of variation for semi arid climate was the lower this can be due to better management practices in this climate than other ecosystems. Coefficient of variation of arid climate, despite having the lowest number of animals, was much more that may be due to the different management systems which exist among the flocks. Results showed that the effects of herd, year and season of calving were significant for all traits and the fixed factors and age of calving and Holstein gene percent as a covariate, were significant for some traits ($p<0.01$). These results are in general agreement with literature reports, particularly for all traits (Shadadi et al., 2014, Savar Sofla et al., 2011). The age at first calving on ProP trait and Holstein gene effect on CI and

LL traits was not significant (P>0.05) as well as the climate effect was significant for all traits except DP and AFC (Table 4).

Table 4: Least square mean and difference least square mean between two climates

Trait-Climate	Arid	Semi dry	difference
Milk	6811(±35)	7013(±13.5)	-202*
Fat	213(±1.5)	227(±0.57)	-14*
Pro	208(±1.2)	220(±0.5)	-12*
FatP	3.15(±0.01)	3.26(±0.006)	-0.11*
ProP	3.08(±0.007)	3.15(±0.003)	-0.07*
LL	302(±1.2))	309(±0.45)	-7*
DP	71(±0.6)	70(±0.24)	+1 NS
AFC	26.91(±0.09)	26.92(±0.03)	-0.01 NS
CI	371(±1)	378(±0.4)	-7*

*Significant at level 0.05 and NS non significant

The current result showed significant difference least square mean for least square means of traits in semi arid climate was greater than arid climate. This means that management was better for all traits except CI trait in semi arid climate. The estimated heritabilities for arid and semi arid

Climate were 0.23, 0.27, 0.39, 0.28, 0.41, 0.04, 0.006, 0.23 and 0.04 for production and reproductive traits (Milk, Fat and FatP, Pro and ProP, LL, DP, AFC and CI), respectively and 0.21, 0.18, 0.08, 0.11, 0.34, 0.03, 0.02, 0.10 and 0.05, respectively (Table 5, 6).

Table 5: Estimates of phenotypic variance (σ_p^2); genetic variance (σ_a^2); residual variance (σ_e^2); heritabilities (h^2±Standard Error**)** in arid climate

Trait	σ_a^2	σ_e^2	σ_p^2	h^2(SE)
Milk	231122	804172	1043294	0.23(0.04)
Fat	386	1052	1438	0.27 (0.05)
FatP	0.07	0.11	0.18	0.38 (0.05)
Pro	235	614	849	0.28 (0.05)
ProP	0.013	0.02	0.033	0.40(0.05)
LL	62	1510	1572	0.04 (0.03)
DP	2	296	298	0.006 (0.02)
AFC	1.1	3.7	4.8	0.23(0.05)
CI	75	2056	2131	0.04(0.005)

The results showed heritability of traits (Milk, Fat, FatP, Pro, ProP and AFC) in arid climate was higher than semi arid climate.

Salimi et al. (2008) reported the heritability milk and fat yield in arid and semi aridwas 0.24, 0.24 and 0.25, 0.19, respectively. Saghi (2001) stated heritability of Milk, Fat, FatP and CI in arid was 0.29, 0.29, 0.18 and 0.09, respectively and in semi arid was 0.29, 0.23, 0.16 and 0.02, respectively.

The results of this research were similar to the finding Salimi et al. (2008) and Saghi (2001), who estimated heritability for milk and fat yield in different climates of Iran. Sahdadi et al. (2014) heritability Milk, Fatp, ProP, AFC, LL, DP and CI traits in Holstein of Iran reported 0.20, 0.28, 0.33, 0.03, 0.08, 0.02 and 0.04, respectively, Farhangfar and Naeemipour (2007) stated 0.31, 0.23, 0.31, 0.14, 0.03 and 0.05 for Milk, Fat, FatP, AFC, DP and CI, respedtively. Solemani-Baghshah et al. (2014) reported heritability of AFC and CI for Isfahan Holstein dairy cattle (arid climate) was 0.19 and 0.06. Therfore For Holestein dairy cattle in Iran, heritability estimates were varied from 0.20 to 0.31 for Milk, and 0.22 to 0.23 for Fat, and 0.25 Pro, and 0.28 to 0.31, and 0.33 for ProP, and 0.03 to 0.10 for LL, and 0.02 to 0.07, and CI 0.04 to 0.09 and AFC were 0.08 to 0.19. Sahin et al. (2014) reported heritability of Milk, LL, DP and CI in Turkey Brown Swiss was 0.25, 0.10, 0.07 and 0.06 respectively.

Table 6: Estimates of phenotypic variance (σ_p^2); genetic variance (σ_a^2); residual variance (σ_e^2); heritabilities (h^2±Standard Error) in semi-arid climate

Trait	σ_a^2	σ_e^2	σ_p^2	h^2(SE)
Milk	211509	789455	1000964	0.21(0.01)
Fat	227	1043	1270	0.18 (0.01)
FatP	0.02	0.26	0.28	0.08 (0.007)
Pro	158	699	857	0.19 (0.01)
ProP	0.01	0.02	0.03	0.34(0.01)
LL	59	1927	1986	0.03(0.005)
DP	5	317	322	0.02 (0.004)
AFC	0.5	4.2	4.7	0.10 (0.009)
CI	78	1641	1719	0.05 (0.03)

Heritability estimtaes for traits in semi aridclimate were within the range except FatP that very low and in arid climate Milk and CI traits were within the range but Fat, Pro, FatP, ProP and AFC higher than other reserch and DP was lower.

The low heritabilities of these traits illustrate that a major part of the variation in these characters are environmental and selection would be not effective in bringing about genetic improvement. In this research the heritabilities for milk, protein and fat yield, fat and protein percentage and age at first calving were moderate. Therefore, selection for these traits will be more effective than selection for characteristics with lower heritabilities.

The foremost portion of variation in calving interval, lactation length and dry period is due to non genetic factors and significant response could be expected by improving environmental conditions such as nourishing and management systems. Therefore, improving the environmental conditions could lead to a significant decrease in length of dry period and calving interval. Makuza and McDaniel (1996) suggested that the low heritability for dry period (DP) indicated that temporary environmental influences were much greater than genetic influences or permanent environmental effects.

Most heritability literature estimates for dry period, lactation length and calving interval is low. These findings indicate that the variation observed is more a result of environmental conditions than genetic differences. This being the case, genetic improvement would not be easily or quickly obtained using standard selection practices.

CONCLUSION:

The current result showed significant difference least square mean for least square means of traits in semi arid climate was greater than arid climate. This means that management was better for all traits except CI trait in semi arid climate but heritability estimate for traits heritability of traits Milk, Fat, FatP, Pro, ProP and AFC in arid climate was higher than semi arid climate.

ACKNOWLEDGMENTS:

The authors are grateful to the Animal Breeding Center of Iran for providing the data used in the present study.

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