The Genetic Parameters for Milk, Fat and Protein Yields in Holstein Cows

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Abstract

The aim of this study was to analyse methodology of genetic parameters estimation and breeding value prediction for milk, fat and protein yield in the first lactation of Holstein cattle using Best Linear Unbiased Prediction procedure-Restricted Maximum Likelihood method with individual animal model. The cows with records in first lactation were from experimental farm of National Research-Development Institute for Animal Biology and Nutrition Balotesti. The genetic parameters were estimated with Restricted Maximum Likelihood method using Individual Animal Model. The estimated heritabilities were 0.249 for milk yield, 0.339 for fat yield and 0.315 for protein yield. The data were analysed with R software. The breeding values of the best Holstein cows for milk yield ranged from 21.13 to 176.97 l, for fat yield ranged from 5.178 to 35.34 kg and for protein yield ranged from 5.516 to 25.155 kg.

Keywords: breeding value, animal model, heritability, cows

1. Introduction

Holstein breed is a breed with high milk, fat and protein yields. The best Linear Unbiased Prediction (BLUP) became the method for genetic evaluation of cattle. The animal model uses the relationship between animals and all available sources of information: own records, parents' records, collaterals and descendants' records [1, 2]. The animal model can be used to estimate instantaneously the breeding values for cows.

Recently, more attention has been placed on milk quality traits in breeding programmes. Selection of cattle is based on the breeding value for milk production traits (milk, fat and protein yield).

Genetic parameters estimated with Restricted Maximum Likelihood (REML) -Animal Model analysis for milk yield have been reported by different authors: Swalve and Van Vleck [3], Van Vleck and Dong [4], Dong et al. [5], Albuquerque et al. [6, 7], Mashadi et al. [8].

The aim of this study was to analyse methodology of genetic parameters estimation and breeding value prediction for milk, fat and protein yield in the first lactation of Holstein cattle using BLUP procedure - REML method with individual animal model.

2. Materials and methods

In this study were analysed the records of 30 cows Holstein in the first lactation. All animals were raised in similar conditions in the experimental farm of National Research-Development Institute for Animal Biology and Nutrition. Traits analysed were 305-day lactation milk, fat and protein yields. The data collected in the year 2015 were used in this study. The fixed effect was the season of calving.

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Statistical analysis. The data were analyzed with animal model with R software (done by Horia Grosu [1, 2]).
The model is [1, 2]:

$$y=Xb+Za+e$$

X= the incidence matrices for fixed effects
Z= the incidence matrices for additive genetic effects
y= the vector of observations
b= the vector of the fixed effects
a= the vector of the additive genetic effects of cows
e= the vector of error
The mixed model-like equations was:

$$\begin{pmatrix} X'X & X'Z \\ Z'Z & Z'Z + A^{-1}K \end{pmatrix} \begin{pmatrix} \tilde{b} \\ \hat{a} \end{pmatrix} = \begin{pmatrix} X'Y \\ Z'Y \end{pmatrix}$$

$$k = \frac{1-h^2}{h^2}$$

The variance components were estimated:

$$\sigma_e^2 = \frac{P'P - \tilde{b} * X' * P - \hat{a}' * ZP}{n - r(X)}$$

σ^2_e= residual variance
where r(x)= rank of matrix X which is the number of linearly independent columns, known as a degrees of freedom for fitting the fixed effects of the model [1]

$$\sigma_a^2 = \frac{\hat{a}' * A^{-1} * \hat{a} + \sigma_e^2 * tr(A^{-1} * C_{22})}{q}$$

σ^2_a= the additive genetic variance
where C_{22}=the sub-matrix corresponding to random effects in the system of equations which was obtained after reversed throughout the system of equations:

$$C = \begin{bmatrix} X'X & X'Z \\ Z'X & Z'Z + A^{-1} * k \end{bmatrix}^{-1} = \begin{bmatrix} C_{11} & C_{12} \\ C_{21} & C_{22} \end{bmatrix}$$

The heritability for milk yield traits was estimated as:

$$h^2 = \frac{\sigma_a^2}{\sigma_a^2 + \sigma_e^2}$$

Where σ^2_a= the additive genetic variance
σ^2_e= residual variance

3. Results and discussion

In our study the average milk yield was 6244.64 litres at 305 days in first lactation in Holstein breed. The average fat yield was 257.29 kg and the average protein yield was 206.99 kg.

Table 1. The heritability for milk, fat and protein yields

Trait	Heritability
Milk yield	0.249
Fat yield	0.339
Protein yield	0.315

Table 2. The breeding values of the best Holstein cows for milk yield

No. of cows	Estimated breeding value for milk yield
1	176.974
2	151.408
3	118.032
4	78.055
5	66.062
6	60.408
7	60.408
8	43.830
9	36.796
10	21.113

Table 3. The breeding values of the best Holstein cows for fat yield

No. of cows	Estimated breeding value for fat yield
1	35.334
2	21.421
3	18.007
4	13.211
5	11.639
6	11.605
7	10.290
8	9.164
9	5.520
10	5.178

Table 4. The breeding values of the best Holstein cows for protein yield

No. of cows	Estimated breeding value for protein yield
1	25.155
2	23.220
3	21.482
4	18.948
5	13.191
6	12.632
7	8.531
8	8.080
9	7.171
10	5.516

In the Table 1 were shown the heritability estimates for the milk production traits in Holstein cows.

The heritability in our study was 0.249 for the milk yield, 0.339 for fat yield and 0.315 for protein yield in Holstein breed in the first lactation. The heritability for milk yield in our study was lower that the heritability found by different authors [4], [6, 8, 9].

The estimated heritability reported by Van Vleck and Dong [4] was 0.36, 0.35 and 0.33 for milk, fat and protein yield in the first lactation. Albuquerque et al. [6] found heritability of 0.34, 0.35 and 0.4 for milk, fat and protein yield in the first lactation.

Mashhadi et al. [8] found the heritability of 0.35, 0.33 and 0.31 for milk, fat and protein yield in Iranian Holstein cows in first lactation.

Dedkova and Wolf [9] reported heritability of 0.30, 0.28 and 0.30 for milk yield 0.24, 0.25 and 0.25 for fat yield and 0.25, 0.25 and 0.27 for protein yield in first, second and third lactations. The heritability estimates in our study were higher than the heritability estimates reported by Dematawewa et al. [10] 0.196, 0.177 and 0.179 in Holstein from U.S.A, Campos et al. [11] 0.21, 0.24 and 0.17 for milk, fat and protein yields in Holstein cows from Brazil and Zaabza et al. [12] 0.21, 0.15 and 0.158 for milk, fat and protein yields in Tunisian Holstein dairy cattle. Also, Cho et al. [13] obtained the lower heritability for milk, fat and protein yield: 0.23, 0.19 and 0.19 in first lactation Holstein cows.

Rushdi et al. [14] obtained the heritability for milk yield 0.25 in Holstein Friesian cattle in Egypt.

Heritability reported by Padilha et al. [15] for 305-day yield from lactation models in Brazilian Holstein was 0.24 for fat and 0.17 for protein.

In the tables 2, 3 and 4 were shown the breeding values for the best cows Holstein.

The breeding values of the best Holstein cows for milk yield in our study ranged from 21.13 to 176.97

l, for fat yield ranged from 5.178 to 35.34 kg and for protein yield ranged from 5.516 to 25.155 kg.
Mashhadi et al. [8] reported mean of breeding values of sires 180.2 kg, 3.7 kg and 2.3 kg for milk, fat and protein yield.
Padilha et al. [15] estimating breeding value for 305-day fat and protein yields by year of birth of cows and bulls showed positive trends ranging between 0.16 and 0.42 kg per year and between 0.47 and 0.76 kg per year in Brazilian Holstein breed. Genetic trend value in the literature ranged between 0.25 and 0.60 kg per year for 305-day fat yields and around 0.45 for 305-day protein yields [16].

4. Conclusions

The heritability was moderate for milk, fat and protein yields in Holstein cattle for 305 day in the first lactation.
For genetic improvement of milk production traits in Holstein population the selection could be based on the highest breeding value of cattle.

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