Consequences of the use of different procedures to adjust milk yield for age of cow at calving in the Brazilian Dairy Gyr Breeding Program

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Abstract

The objective of this study was to evaluate the use of different procedures to adjust milk yield for age of cow at calving, it consequences on the estimates of (co)variance components and genetic parameters, and sire and cow ranking. Data were obtained from 39,151 lactations of 16,898 Gyr dairy cows, daughters of 1,636 sires. Large differences in adjusted phenotypic values and (co)variance components for milk yield were observed between analyses using multiplicative adjustment factors and that including cow's age as classificatory effect or as covariate in the model. Spearman's correlation coefficients between the 10 highest sire breeding values ranged from 0.83 to 0.98. The largest variation in the correlations was observed for cows (0.61 to 0.99). Irrespective of the procedure used to adjust milk yield for age of cow at calving, the five top sires previously defined based on breeding values were the same. The procedure used for the adjustment of milk yield for age of cow at calving changed the parameters estimated in the genetic evaluations of the Brazilian Dairy Gyr Breeding Program, but interferes little with the identification of sires with superior genotypes.

Keywords: Gyr breed, (co)variance components, heritability, milk yield.

1. Introduction

In Brazil, genetic breeding programs of dairy cattle populations have reached expressive progress, especially over the last decade (Verneque et al., 2009; Peixoto et al., 2009). Part of this progress can be attributed to the use of adequate methods for genetic evaluation and to the knowledge of the genetic merit of animals for milk production.

Milk yield is directly related to physiological aspects at each developmental stage of the cow. Females at the beginning and at the end of their productive life show a lower performance than the mature ones. The low milk yield at the beginning of productive life is associated with the physiological exhaustion of heifers due to both lactation and concomitant accelerated growth and maintenance (Wathes et al., 2007). At the end of productive life, the decline in milk yield is related to a reduced ability of females to satisfy their nutritional requirements, in addition to other factors associated with aging. Thus, the study on the procedures to adjust milk yield for cow's age at calving is important to increase the accuracy of genetic evaluations and so selection, increasing the possibility of greater genetic gains in animal breeding programs. In addition, adjustment factors are used by breeders to compare animals of different ages and then proceed to selection into the herd.

Since the phenotypic and genetic parameters may change during selection in a breeding program, evaluation of the results and reestimation of parameters are essential. It allows keeping accuracy and efficiency supposing that animal population undergoes a constant process of artificial evolution. The objective of the present study was to evaluate the consequences of the use of different adjustment procedures of milk yield for age of cow at calving on the estimates of (co)variance components, genetic parameters and ranking of sires and cows.

2. Material and Methods

Data used in this study were obtained from the Brazilian Dairy Gyr Breeding Program under the coordination of Embrapa Gado de Leite (Brazilian Dairy Cattle Research Center) and Brazilian Association of Dairy Gyr Breeders (ABCGIL). It was analyzed a total of 39,151 lactations records from 16,898 cows, daughters of 1,636 sires, belonging to 240 herds, whose calving occurred between 1960 and 2008. The calving age of cows ranged from two to 19 years and only herds with at least three animals were kept. Only records for lactations with length equal or above 50 days were used in this analysis. In addition, lactations longer than 305 days were truncated at this moment.

The trait analyzed was 305-day milk yield. To remove the effect of cow's age at calving four procedures were used: i) application of old multiplicative adjustment factors for age at calving, estimated from lactations recorded until 1994, and concomitant inclusion of cow's age as a covariate (**A1**); ii) application of multiplicative adjustment factors for age of cow at calving, estimated as a function of calving seasons and milk yield level of the herd considering complete data file (**A2**); iii) inclusion of cow's age at calving in the model as a covariate (**A3**) and iv) inclusion of cow's age at calving in the model as a classificatory effect (**A4**).

Fixed effects were herd-year, calving season and management group. The effect of calving season was defined as dry (April to September) and rainy (October to March) for herds from the Southeastern, and as dry (October to March) and rainy (April to September) for herds from the Northeastern Brazil. The 305-days milk yield averages were used as a criterion for the designation of herds the three groups of milk yield level: low (< 2,350 kg), medium (2,350 to 2,800 kg) and high (> 2,800 kg).

Analyses were performed using MTDFREML package (Boldman et al., 1995). The following general model was used: $\mathbf{y} = \mathbf{Xb} + \mathbf{Za} + \mathbf{Zp} + \mathbf{e}$, where **y** is the vector of observations; **b** is the vector of solutions for fixed effects; **a** and **p** are vectors of solutions for, respectively, random animal and permanent environmental effects, inherent to the repetition of observations for each cow; **X** is the incidence matrix of fixed effects; **Z** is the incidence matrix of random effects, and **e** is the vector of residual effects.

Changes in the classification of sires and cows as a result of the use of different adjustment procedures for cow's age at calving were evaluated by Spearman's correlation between rankings of breeding values using the SAS® (SAS, 2004).

3. Results

The results of descriptive statistics for 305-day milk yield using the different adjustment procedures are shown in table 1. Adjustment procedures A1 and A2, as well as A3 and A4, presented each similar descriptive statistics. Moreover, large differences were observed between A1/A2 and A3/A4.

The estimates of (co)variance components and genetic parameters for milk yield obtained with different adjustment procedures are shown in table 2. In general, broad differences in the (co)variance components were observed between analyses using multiplicative adjustment factors (A1 and A2) and those including cow's age only as a classificatory variable or as a covariate (A3 and A4). When A1 was used for adjusting milk yield the (co)variance components were a little higher than that obtained with A2. For A2, there was a reduction in estimates of 6.03, 0.59, 0.42 and 2.11% to, respectively, additive genetic, permanent environmental, residual and phenotypic (co)variances between them. Similar (co)variance components were obtained for A3 and A4. Estimates of heritability for milk yield were similar for A1 and A2, but higher when compared to A3 and A4.

Spearman's correlation coefficients between the 10 top sires ranked based on their breeding value for milk yield ranged from 0.83 to 0.98. A wide variation in breeding values ranging from 0.61 to 0.99 was observed for cows. Analysis of the ranking of the 10 top sires obtained with each adjustment procedure revealed the presence of almost the same animals, with the additional inclusion of two sires (K and L). As it can be seen in table 3, the best five sires for milk yield are exactly the same obtained when using the different adjustment procedures for cow's age at calving. For cows, different cows were observed among the classification of the 20 best cows based on breeding values according to the adjustment procedure used (Table 4). Differences were expressive between A1/A2 and A3/A4.

4. Discussion

Differences in the adjusted variances of 305-days milk yield observed when milk yields were multiplied by the adjustment factors in procedures A1 and A2, pointed out the similarity between the multiplicative factors obtained.

The results showed that the use of multiplicative adjustment factors for age of cow at calving instead of including age as a classificatory effect or covariate in the model could have overestimated (co)variance components and consequently increased the coefficient of heritability. Despite differences in the heritability estimates obtained in this study, these estimates agree with those reported in the literature for the Gyr breed, ranging from 0.12 to 0.38 (Albuquerque et al., 1996, Lobo et al., 2000, Herrera et al., 2008).

The correlation coefficients obtained for sires indicate the absence of major changes in sire ranking in function of the procedure used for the adjustment of cow's age at calving. Probably, because the impact of the use of proven sires on the means and (co)variances is still low, due to the recent beginning of sire summary publication (1993). However, the changes in cow ranking observed suggest closer attention to the procedure used when adjusting milk yield for cow's age.

The present results showed little changes in phenotypic values, (co)variance and heritability estimates and cow classification for 305-day milk yield when using different adjustment procedures for cow's age instead of including this effect in the model as a classificatory variable or as a covariate. Since the main tool used by breeders is the predicted transmission ability (PTA) and the top sires were the same whatever the adjustment procedure, beyond considering that this variable did not undergo major changes, the procedure used to adjust milk yield for cow's age could not interfere with genetic progress of Gyr Dairy cattle.

5. Conclusion

The procedure used to adjust milk yield for age of cow at calving were similar and did not bring consequences about the estimates and ranking of sires proved in the Brazilian Dairy Gyr Breeding Program yet.

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Table 1. Estimates of mean, standard deviation and minimum and maximum 305-day milk yield using different adjustment procedures for age of cow at calving.

Adjustment procedure*	Mean	Standard deviation	Minimum	Maximum
A1	2872.22	1388.57	123.00	17,931.00
A2	2872.02	1404.59	124.00	18,709.00
A3	2566.47	1217.76	103.00	16,676.00
A4	2566.46	1217.15	103.00	16,676.00

* A1=old factors with age as covariate included in the model; A2=new factors estimated in function of the herd production level and calving season; A3=age as covariate included in the model and A4=age as a classificatory effect included in the model.

Table 2. Estimates of (co)variance components and genetic parameters for 305-day milk yield using different adjustment procedures for age of cow at calving.

Adjustment procedure	σ_A^2	σ_{AP}^2	σ_E^2	σ_P^2	h^2	c^2
A1	291,755.87	205,876.00	452,938.19	950,570.45	0.31±0.002	0.22±0.007
A2	275,158.99	204,675.00	451,059.84	930,893.96	0.30±0.002	0.22±0.007
A3	196,871.73	154,193.00	376,233.09	727,298.19	0.27±0.002	0.21±0.007
A4	196,715.33	155,346.00	373,265.74	725,327.13	0.27±0.002	0.21±0.007

σ_A^2: additive genetic variance; σ_{AP}^2: permanent environmental variance; σ_E^2: residual variance; σ_P^2: phenotypic variance; h^2: heritability; c^2: permanent environmental variance as a proportion of phenotypic variance.

Table 3. Classification of sires according to the highest breeding values for 305-day milk yield using the different adjustment procedures for age of cow at calving in the Brazilian Dairy Gyr Breeding Program.

Sire position	Adjustment procedure*			
	A1	A2	A3	A4
1st	A	B	D	D
2nd	B	A	A	A
3rd	C	C	C	C
4th	D	D	E	B
5th	E	E	B	E
6th	F	F	F	F
7th	G	G	G	G
8th	H	K	H	J
9th	I	J	J	H
10th	J	H	L	L

* A1=old factors with age as covariate included in the model; A2=new factors estimated in function of the herd production level and calving season; A3=age as covariate included in the model and A4=age as a classificatory effect included in the model.

Table 4. Classification of cows according to the highest breeding values for 305-day milk yield using the different adjustment procedures for age of cow at calving in the Brazilian Dairy Gyr Breeding Program.

Cow position	Adjustment procedure			
	A1	A2	A3	A4
1st	A	A	A	A
2nd	B	B	L	L
3rd	C	I	H	C
4th	D	K	D	H
5th	E	C	C	D
6th	F	M	**Z**	**Z**
7th	G	D	F	G
8th	H	R	**X**	F
9th	I	G	G	J
10th	J	H	E	E
11th	K	E	J	**X**
12th	L	F	Q	Q
13th	M	O	N	N
14th	N	N	**U**	P
15th	O	J	P	T
16th	P	S	**Y**	B
17th	Q	P	T	I
18th	R	L	**W**	**Y**
19th	S	**V**	B	**W**
20th	T	**α**	I	M

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