Genetic parameters estimates for milk, fat and protein yield analyzed by test day models for Murrah buffaloes in Brazil

R. Aspilcueta-Borquis[1,2], A. Tanaka[1,2], L. Albuquerque[1,2], R. Sesana[1], L. Seno[1,2], A. Bignardi[1,2], H. Tonhati[1,2]

[1] University of São Paulo State, FCAV/UNESP – Jabotical, Department of Animal Sciences, São Paulo State, Brazil

[2] Lagoa da Serra Company Sertãozinho, Brazil

Corresponding author: H. Tonhati- FCAV/UNESP - Jaboticabal, SP-BRAZIL CEP 14884-900 - Tel. +55 16 32092678 - Fax: 55 16 32092685 - Email:tonhati@fcav.unesp.br

ABSTRACT: The objectives of this study were to estimate genetic parameters for test-day milk, fat and protein yields, in Murrah buffaloes. In this study 4,757 complete lactations of Murrah buffaloes were analyzed. The (co) variance components were estimated by restricted maximum likelihood using MTDFREML software. The bi-trait animal test-day models included genetic additive direct and permanent environment effects, as random effects, and the fixed effects of contemporary group (herds-year-month of control) and age of the cow at calving as linear and quadratic covariable. The heritability estimate at first control was 0.19, increased until the third control (0.24), decreasing thereafter, reaching the lowest value at the ninth control (0.09). The highest heritability estimates for fat and protein yield were 0.23 (first control) and 0.33 (third control), respectively. For milk yield, genetic and phenotypic correlation estimates ranged from 0.37 to 0.99 and from 0.52 to 0.94, respectively. Genetic correlations were higher than phenotypic ones. For fat and protein yields, genetic correlation estimates ranged from 0.42 to 0.97.

Key words: Phenotypic correlation estimates, Genetic correlation estimates, Heritability estimates.

INTRODUCTION - With test-day models (TDM), milk yield in the day of record, defined as the sum of milk yield of a cow during 24 hours, is analyzed instead of 305 days milk yield (M305). With a TDM is possible to take into account effects specific to day at record, which do not change only from one animal to another but also among records of the same animal. Therefore, compared to the traditional M305 model, with the TDM the environmental effects are better modelled, increasing the accuracy of genetic parameter estimates and selection response. Different methods have been proposed to estimate the (co) variance structure among TD. In methods using multi trait analysis, different test-day yields are treated as different traits but the covariance matrix is not structured and do not allow a continuous description of the changes in (co)variances with days in milk. Estimates of heritability are sometimes similar to those reported for 305-d milk yield, specially for midlactation records, for both, dairy cattle (Ganidini 1997; Jamrozik and Schaeffer 1997; Silvestre et al., 2004 and Bignardi 2006) and milking buffaloes (Hurtado-Lugo et al., 2006). Silvestre et al. (2004) and Bignardi (2006) observed higher phenotypic and genetic correlations for adjacent records. The objectives of the present study were to estimate genetic parameters for TD Murrah buffaloes milk, fat and protein yields.

MATERIAL AND METHODS - A total of 42,813 milk and 7,008 protein and fat monthly test-day records, were analyzed. Data were recorded from 1985 to 2005 and belonged to ABCB (Asociação Brasileira Criadores de Búfalos) - São Paulo state (Brazil).

The (co) variance components were estimated by restricted maximum likelihood using MTDFREML software, for 1^{st} to 9^{th} month of lactation. The bi-trait animal test-day models included genetic additive direct and permanent environmental effects, as random and the fixed effects of contemporary group (herd-year-month of control) and age the cow at calving as linear and quadratic covariable.
The model in matrix notation is:

$$y = X\beta + Za + Wp + e;$$

Where y is a vector containing the data (milk, fat and protein yield), and X, Z and W are incidence matrixes relating y to ß, a and p, the vectors of fixed effects (contemporary group and age of the cow at calving), and as random the genetic and permanent environmental effects, respectively, and e is the residual variance.

RESULTS AND CONCLUSIONS - Estimates of additive genetic, permanent environmental and phenotypic variances and heritabilities are in Table 1. The additive genetic variance estimate at first control was 0.88 kg^2, increased until the third control (1.11kg^2), decreasing thereafter, reaching the lowest value at the ninth control (0.30 kg^2). Bignardi (2006) reported similar results in dairy cattle. However, Hurtado-Lugo, et al. (2006) reported higher additive genetic variance at the fifth control. The highest additive genetic variances for fat and protein yield were at first control. Silvestre et al., (2004), observed a very similar pattern of variance estimates for milk, fat and protein yields. For milk yield, the heritability estimates showed the same trend as the genetic variance estimates (Table 1). These results are in agreement with those from Gadini (1997); Jamrozik and Schaeffer, (1997) and Silvestre et al., (2004). Hurtado-Lugo et al., (2006) and Bignardi (2006) reported the highest heritability values for milk yield at the first control and at the third control, being the values 0.23 and 0.33, respectively. Heritability estimates for fat and protein yields decreased with days in milk.
Genetic (r_g) and phenotypic (r_p) correlation estimates between test days are in Table 2. For milk yield, r_g and r_p were positive and ranged from 0.37 to 0.99 and from 0.52 to 0.94, respectively. At midlactation genetic correlations estimates were the highest. Bignardi (2006) reported higher estimates of genetic correlations between TD yields than in the present study. For fat and protein yields, genetic correlation estimates were positive and ranged from 0.42 to 0.97. The r_p for fat and protein yields were lower than for milk yield.
Genetic variance estimates for milk, fat and protein yields at the first four controls indicate that selection for these traits would be effective. Genetic correlation estimates indicated that selection to increase milk, protein or fat yields at any control will change yields at any another control.

Table 1. Estimates of heritability (h^2), additive genetic (σ^2_a), permanent environmental (σ^2_{ap}) and phenotypic (σ^2_p) variances (in kg^2) for milk, fat and protein yields by month (M) of record.

M	Milk				Fat[1]				Protein[1]			
	σ^2_a	σ^2_{ap}	σ^2_p	h^2	σ^2_a	σ^2_{ap}	σ^2_p	h^2	σ^2_a	σ^2_{ap}	σ^2_p	h^2
1	0.88	0.98	4.72	0.19±0.04	3.71	1.30	16.01	0.23±0.10	2.25	0.36	7.05	0.32±0.01
2	0.99	1.34	4.57	0.22±0.04	3.02	1.26	14.38	0.21±0.07	2.03	0.28	6.34	0.32±0.09
3	1.11	1.39	4.66	0.24±0.04	2.57	2.43	15.35	0.17±0.09	1.71	0.04	5.24	0.33±0.10
4	0.82	1.26	4.23	0.19±0.04	2.75	1.32	15.25	0.18±0.09	1.14	0.35	5.27	0.22+0.09
5	0.82	1.20	4.06	0.20±0.04	2.13	1.36	15.21	0.14±0.05	0.50	0.91	4.56	0.11±0.08
6	0.68	1.01	3.66	0.19±0.03	1.16	1.51	14.67	0.08±0.07	0.63	0.86	5.76	0.11±0.09
7	0.35	1.03	3.21	0.11±0.04	1.48	2.22	12.95	0.11±0.09	0.68	0.48	4.14	0.16±0.09
8	0.36	0.84	3.27	0.11±0.04	1.09	2.02	13.79	0.08±0.08	0.17	1.36	4.43	0.04±0.07
9	0.30	1.23	3.24	0.09±0.05	1.62	5.11	17.19	0.09±0.08	0.26	2.12	5.50	0.05±0.07

[1]The variance estimates were multiplied by 10^3

Table 2. Estimates of genetic (above diagonal) and phenotypic correlations (below diagonal) for milk, fat and protein yields by month of record.

		1	2	3	4	5	6	7	8	9
Milk	1		0,92	0,86	0,87	0,80	0,78	0,56	0,68	0,61
	2	0,82		0,96	0,93	0,93	0,88	0,60	0,86	0,73
	3	0,79	0,79		0,99	0,88	0,98	0,56	0,64	0,62
	4	0,70	0,62	0,84		0,98	0,98	0,58	0,86	0,67
	5	0,62	0,58	0,63	0,87		0,97	0,65	0,50	0,37
	6	0,58	0,58	0,60	0,61	0,87		0,99	0,89	0,77
	7	0,57	0,55	0,60	0,56	0,69	0,94		0,65	0,50
	8	0,55	0,52	0,53	0,55	0,43	0,75	0,83		0,87
	9	0,53	0,52	0,52	0,52	0,62	0,65	0,66	0,77	
Fat	1		0,97	0,89	0,82	0,80	0,74	0,67	0,52	0,42
	2	0,53		0,93	0,88	0,78	0,71	0,65	0,56	0,45
	3	0,47	0,51		0,97	0,91	0,79	0,72	0,58	0,48
	4	0,42	0,49	0,49		0,95	0,91	0,71	0,62	0,55
	5	0,39	0,43	0,42	0,51		0,96	0,89	0,69	0,60
	6	0,31	0,37	0,39	0,48	0,52		0,97	0,89	0,76
	7	0,25	0,31	0,36	0,42	0,43	0,55		0,97	0,88
	8	0,23	0,26	0,32	0,31	0,46	0,52	0,57		0,96
	9	0,24	0,27	0,30	0,36	0,39	0,49	0,54	0,59	
Protein	1		0,97	0,84	0,71	0,58	0,64	0,61	0,58	0,42
	2	0,64		0,94	0,88	0,82	0,82	0,70	0,72	0,64
	3	0,59	0,61		0,97	0,89	0,78	0,69	0,64	0,61
	4	0,52	0,58	0,57		0,97	0,91	0,88	0,84	0,79
	5	0,42	0,52	0,51	0,62		0,95	0,93	0,87	0,83
	6	0,38	0,47	0,40	0,56	0,63		0,97	0,92	0,85
	7	0,33	0,43	0,43	0,48	0,60	0,70		0,97	0,89
	8	0,28	0,40	0,40	0,53	0,51	0,61	0,61		0,95
	9	0,24	0,29	0,39	0,40	0,47	0,54	0,56	0,68	

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