Evaluation of development traits of beef buffalo in Brazil using multivariate analysis

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ABSTRACT: The buffalo population in Brazil increased about 12.9% between 1998 and 2003, to 2.8 million head, evidencing the importance of this species for the country. The objective this work was evaluation of animal growth using multivariate analysis. The data were from 2,944 water buffalo from 10 herds raised in pasture conditions in Brazil. Principal components and genetic distances were estimated using proc PRINCOMP and proc CANDISC in SAS (SAS Inst. Inc. Cary, NC, USA). Variables analyzed were birth weight (BW), age at weaning (AW), weaning weight (WT), weight adjusted to 205 d (W205), total gain between BW and WT (TG), daily gain between BW and WT (DG), weight adjusted to 365 d (W365), total gain between WT and W365 (TG3), daily gain between WT and W365 (TGD3), weight adjusted to 550 d (W550) and weight adjusted to 730 d (W730). Means and standard deviations for each variable were 39.4 ± 3.2 kg, 225.6 ± 38.8 d, 209.4 ± 39.4 kg, 195.4 ± 30.2 kg, 157.4 ± 32.0 kg, 0.77 ± 0.16 kg/d, 282.0 ± 43.5 kg, 73.9 ± 33.9 kg, 0.53 ± 0.21 kg/d, 406.8 ± 67.9 kg, and 468.2 ± 70.6 kg, respectively. The eigenvalues to four first principal components were 5.29, 2.54, 1.66, 1.01, and justify 48%, 23%, 15% and 9%, respectively, with a total cumulative 95%. We created an index using the first principal component which is Y= 0.0552 BW + 0.0438 AW + 0.3142 WT + 0.3549 W205 + 0.3426 TG + 0.3426 DG + 0.4070 W365- 0.1531 TG3 - 0.2059 TGD3 - 0.3833 W550 - 0.3966 W730. This index accounted for 48% the variation in the correlation matrix. This principal component emphasizes early growth of the animal. Estimates the pair-wise squared distances between herds, $D^2(i|j)= (\bar{x}_i-\bar{x}_j)' \, cov^{-1}(\bar{x}_i-\bar{x}_j)$, using with basis the average of weight of animals, showed the largest distance between herds eight (Murrah: DF) and seven (Murrah: Amazon) and the closest distance between herds one (Mediterranean - RS) and five (Jafarabadi - SP).

Key words: Gain, Murrah, Weight.

INTRODUCTION - In 2003 the buffalo population in Brazil was 2.8 million head, an increase of 12.9% since 1998. Many traits are recorded in production. The use of multivariate analysis permits combining traits as principal components into a smaller set which

can be used in a selection program. In principal component analysis the variance explained by a component is equal to the eigenvalue of either the covariance or the correlation matrix used in the analysis (Timm, 2002). The objective this work was evaluation of animal growth using multivariate analysis.

MATERIAL AND METHODS - The data were from 2,944 water buffalo from 10 herds [herd number: breed (state) and number of animals: 1: Mediterranean (Rio Grande do Sul) n = 1937; 2: Jafarabadi (São Paulo) n = 40; 3: Murrah (Pará) n = 141; 5: Jafarabadi (São Paulo) n = 59; 6: Mediterranean (São Paulo) n = 116, 7: Murrah (Pará) n = 13; 8: Murrah (Brasilia) n = 30; 9: Mediterranean (Bahia) n = 320; 141: Murrah (Paraná) n = 130; 142: Murrah (Paraná) n = 152] raised in pasture conditions in Brazil from 1988 to 2002. The breeding program used natural mating in the field, and health practices included vaccinations and ecto- and endoparasite control. Variables measured and derived included birth weight (BW), age at weaning (AW), weaning weight (WT), weight adjusted to 205 d (W205), total gain between BW and WT (TG), daily gain between BW and WT (DG), weight adjusted to 365 d (W365), total gain between WT and W365 (TG3), daily gain between WT and W365 (TGD3), weight adjusted to 550 d (W550) and weight adjusted to 730 d (W730). Principal components were estimated using proc PRINCOMP in SAS (SAS Inst. Inc. Cary, NC, USA). Genetic distances were estimates using the Euclidian method in the CANDISC procedure of SAS.

RESULTS AND CONCLUSIONS - The overall means and standard deviations were 39.4 ± 3.2 kg, 225.6 ± 38.8 d, 209.4 ± 39.4 kg, 195.4 ± 30.2 kg, 157.4 ± 32.0 kg, 0.77 ± 0.16 kg/d, 282.0 ± 43.5 kg, 73.9 ± 33.9 kg, 0.53 ± 0.21 kg/d, 406.8 ± 67.9 kg, and 468.2 ± 70.6 kg for birth weight (BW), age at weaning (AW), weaning weight (WT), weight adjusted to 205 d (W205), total gain between BW and WT (TG), daily gain between BW and WT (DG), weight adjusted to 365 d (W365), total gain between WT and W365 (TG3), daily gain between WT and W365 (TGD3), weight adjusted to 550 d (W550) and weight adjusted to 730 d (W730), respectively.

The correlation between BW and other traits was very small and in some cases was negative. Weaning weight was highly correlated with AW (0.61), W205 (0.65), TG (0.60), DG (0.60), and W365 (0.65), but negative with TG3 (-0.22). In general, W365, W550 and W730 were highly correlated with other traits except BW and AW (table 1).

The eigenvalues for the first four first principal components were 5.29, 2.54, 1.66, and 1.01, and justified 48%, 23%, 15% and 9% of the variance, respectively, and together accounted for 95% of the variance. The coefficients for the first principal component were: +0.0552 for BW, +0.0438 for AW, + 0.3142 for WT, + 0.3549 for W205, + 0.3426 for TG, + 0.3426 for DG, + 0.4070 for W365, - 0.1531 for TG3, - 0.2059 for TGD3, - 0.3833 for W550and - 0.3966 for W730. Thus in the first principal component gave a heavy negative weighting to weights at higher ages, W365 (-0.4070), W550 (-0.3833) and W730 (-0.3966) while weights measured at younger ages were positively weighted. For the second principal component WT, W205, TG and DG were negatively weighted and the highest value was for total post-weaning gain. For the third principal component the highest value was for AW, and for the fourth principal component BW was most heavily weighted. Mascioli et al. (2000) evaluated genetic parameters of beef cattle and reported that the first principal component explained 74% of

total variation, and it is an index of the studied traits, and the importance of each one increased as the animal aged; the second component explained 14% of the variation. Souza et al. (2007a) estimated principal components of crossbred animal in Brazil and reported correlations for BW and W205 (0.32), BW and W365 (0.31), BW and W550 (0.27) and, BW and W730 (0.22); W205 and W365 (0.61), W205 and W550 (0.67) and, W205 and W730 (0.31); W365 and W550 (0.72) and W365 and W730 (0.37); W550 and W730 (0.48). The estimates of eigenvalues were 2.79, 0.83, 0.74, 0.38 and 0.25. This authors report of the first principal component justified 56%; the first and second together 72%, and the first three principal components together explained 87%, and the first four principal components justified 95%. Souza et al. (2007b) evaluate growth and conformation of Brazilian Herefords using principal component analysis and the estimated eigenvalues of the first three principal components to be 5.33 (41%), 3.75 (29%) and 2.03 (16%); and the first principal component, weighted heavily toward growth traits, had similar estimates of genetic parameters as did the traits themselves.

Estimates of the pair-wise squared distances between herds, $D^2(i|j)= (\bar{x}_i-\bar{x}_j)' \, cov^{-1}(\bar{x}_i-\bar{x}_j)$, was calculated based on the average of weight of animals. The values are relative measures of differences in growth from birth to 730 d. Herds linked with small distance values would cluster

Table 1. Correlation estimates between production characteristics of buffalo.

	BW	AW	WT	W205	TG	DG	W365	TG3	TGD3	W550
BW	1.000	-0.027	0.079	0.111	-0.015	-0.015	0.112	0.050	0.072	0.192
AW	-0.027	1.000	0.613	-0.167	-0.185	-0.185	0.213	-0.276	0.219	0.074
WT	0.079	0.613	1.000	0.646	0.603	0.603	0.649	-0.223	0.138	0.490
W205	0.111	-0.167	0.646	1.000	0.967	0.967	0.603	-0.017	-0.046	0.533
TG	-0.015	-0.185	0.603	0.967	1.000	1.000	0.557	-0.033	-0.068	0.495
DG	-0.015	-0.185	0.603	0.967	1.000	1.000	0.557	-0.033	-0.068	0.495
W365	0.112	0.213	0.649	0.603	0.557	0.557	1.000	0.503	0.664	0.890
TG3	0.050	-0.276	-0.223	-0.017	-0.033	-0.033	0.503	1.000	0.721	0.546
TGD3	0.072	0.219	0.138	-0.046	-0.068	-0.068	0.664	0.721	1.000	0.648
W550	0.192	0.074	0.490	0.533	0.495	0.495	0.890	0.546	0.648	1.000
W730	0.108	0.164	0.574	0.556	0.519	0.519	0.946	0.510	0.656	0.930

BW: birth weight; AW: age at weaning; WT: weaning weight; W205: weight adjusted to 205 d; TG total gain between BW and WT; DG: daily gain between BW and WT; W365: weight adjusted to 365 d; TG3: total gain between WT and W365; TGD3: daily gain between WT and W365; W550: weight adjusted to 550 d; W730: weight adjusted to 730 d.

together. The largest distance was between herds 7 Murrah (Pará) and 8 Murrah (Brasilia), eight (Murrah: DF) (Table 2). Herds 141 and 142, two herds of Murrah in Paraná, clustered closely together as might be expected, but curiously, herds 1, 5 and 9 also clustered together and all were of two different breeds and all from different locations. The two larger herds in the latter cluster (herds 1 and 9) were both Mediterranean and herd 5 was very small in number and may have been crossbred although primarily identified as Jafarabadi.

Table 2. Estimates of distance between herds based on cluster analysis of weights.

Herd[1]	1	2	3	5	6	7	8	9	141
1	0.0								
2	23.4	0.0							
3	24.7	39.9	0.0						
5	2.2	26.8	18.3	0.0					
6	10.9	34.1	38.3	11.7	0.0				
7	49.8	64.3	54.5	47.9	49.3	0.0			
8	42.4	68.9	37.4	43.6	57.2	109.1	0.0		
9	3.6	20.8	20.9	3.6	7.2	47.9	48.6	0.0	
141	40.8	59.0	8.9	34.9	57.2	85.1	23.5	38.9	0.0
142	39.8	65.0	19.0	37.2	52.7	87.8	11.6	41.2	4.5

[1] The herd number, buffalo breed, and location are as follows: 1 Mediterranean (Rio Grande do Sul), 2 Jafarabadi (São Paulo), 3 Murrah (Pará), 5 Jafarabadi (São Paulo), 6 Mediterranean (São Paulo), 7 Murrah (Pará), 8 Murrah (Brasilia), 9 Mediterranean (Bahia), 141 Murrah (Paraná), and 142 Murrah (Paraná).

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