

POLYMORPHISM OF PROTEINS IN THE BLOOD OF HORSES: STUDY OF A LOCAL POPULATION (Lavradeiro) OF RORAIMA, BRAZIL

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ABSTRACT

Polymorphisms of proteins in the blood of 99 Lavradeiro horses in the state of Roraima, Brazil, were studied to determine some aspects of the genetic composition of this population. Four genetic systems (transferrins, albumin, phosphoglucomutase, and carbonic anhydrase) were analysed and gene frequencies for four loci were determined. The population was shown to be in Hardy-Weinberg equilibrium, except for the transferrin system. Comparisons of the results with other studies suggested a stronger genetic relationship between the Lavradeiro and Thoroughbreds than was initially suspected.

INTRODUCTION

Studies of various horse breeds have been made using electrophoretic variants of blood proteins, in order to uncover the effect of selection and to work out breed relationships (Blokhuis and Buis, 1979; Kaminski and Nicolas, 1979; Kaminski and Andres Cara, 1986; Bowling and Ryder, 1987; Weitkamp *et al.*, 1988).

The Lavradeiro is a local population of horses found in the state of Roraima, Brazil. This population, which is estimated to be about 1000 mares, originated from the horses introduced in the area by the Portuguese in approximately 1718, and by the Spaniards, through Venezuela, around 1770 (Beck, 1989). These are, most probably, descendants of those that inhabited the Iberian Peninsula as described by Kaminski and Andres Cara (1986). The Lavradeiro horses have been subjected to at least 200 years of natural selection in the harsh environment of the Lavrado, the region that is most repre-

sentative of their habitat. The conservation and study of these horses is of special interest for Brazil, which has one of the largest equine populations in the world (Beck, 1989).

This paper describes some aspects of the genetic constitution of the population through a study of polymorphisms of blood proteins, in four different genetic systems: transferrins (Tf), albumin (Alb), phosphoglucosmutase (PGM), and carbonic anhydrase (CA). Based on gene frequencies obtained for these systems, genetic relationships with some other populations reported in the literature were also investigated.

MATERIALS AND METHODS

Blood samples were taken from 99 Lavradeiro horses belonging to the Flexal Ranch, located in the region known as Lavrado do Marauai in the State of Roraima, in Brazil.

The population size in this farm was about 700 horses, according to the information provided by one of its owners. The herd was kept in very large areas, without fences, in conditions similar to those of horses living in the wild. The population was naturally subdivided into small mating groups composed of different numbers of mares (10-15 on average) led by one stallion. Human interference has been very slight except for the last few years, when some intentional selection of the males has been practiced. In order to reduce the influence of artificial selection on the data, only adult individuals were included in the sampling. Using heparin as anticoagulant, blood was taken from the jugular vein, collected in vacutainer type tubes and kept refrigerated until arrival at the laboratory. The samples were centrifuged for 15 minutes at 5000 rpm at 5°C. Plasma was collected for the electrophoretic analysis of the Tf and Alb types and erythrocytes, washed three times in 0.9 NaCl, were used as sources of CA and PGM. Protein polymorphism were analysed by horizontal starch-gel electrophoresis, using specific techniques for each: Tf by the method of Geldermann (1970), Alb by the method of Kristjansson (1960), PGM by the method of Bengtsson and Sandberg (1973) and CA by the haemoglobin precipitation technique of Shanker *et al.* (1983). Gene frequencies were determined by direct counting of alleles at each of the four loci.

RESULTS AND DISCUSSION

Table I shows observed and expected values of the different protein systems analyzed and the gene frequencies for the different loci. The population was in Hardy-Weinberg equilibrium for the systems studied, except for Tf. alleles Tf^J and Tf^M were not encountered. Similarly, the alleles CA^L and CA^O, and CA^S, described by Sandberg (1968) were not detected. Only the two common CA, namely CA^F and Ca^I alleles were detected.

Table I - A comparison between observed phenotypes and expected phenotypes in Lavradeiro horses.

Phenotypes		Obs	Exp	X ²	Allele frequencies
Tf	DF	25	21.44	9.41*	Tf ^D - 0.268
	FF	16	16.16		Tf ^F - 0.404
	DO	13	9.39		Tf ^H - 0.080
	FO	11	14.16		Tf ^O - 0.177
	FH	7	6.40		Tf ^R - 0.071
	FR	5	5.68		
	DD	4	7.11		
	DR	4	3.77		
	HO	4	2.80		
	DH	0	4.25		
	OO	0	3.10		
	HR	10	11.46		
	OR	0	2.49		
	RR	0	0.50		
HH	0	0.63			
Alb	FF	5	7.38	1.432	Alb ^F - 0.273
	FS	44	39.30		Alb ^S - 0.727
	SS	50	52.32		
PGM	FF	1	0.16	0.07	PGM ^F - 0.04
	FS	6	7.60		PGM ^S - 0.96
	SS	92	91.24		
CA	II	58	58.61	0.374	CA ^F - 0.23
	IF	32	35.04		CA ^I - 0.77
	FF	6	5.25		

*P < 0.05.

The allele frequencies for the Lavradeiro horses are compared with those of other breeds in Table II. The frequencies in the Lavradeiro are, in general, similar to these reported for the Thoroughbreds. The Tf alleles in Lavradeiro horses did not seem to be different in frequency from the majority of the populations compared in Table II, except for the Andalusian and Arab breeds which showed higher frequencies for Tf^H. The albumin allele frequencies were considerably different from the andalusian and the Netherland horses (Arab and Trotter). The PGM allele frequencies like those in other breeds seemed to be different only from the Przewalskii horses.

Table II - Comparison of gene-frequencies in various horse populations.

Breeds	Tf										Alb		PGM		CA			Ref.
	D	F1	F2	H	O	R	E	I	J	F	S	F	S	F	I	L		
Salemitana	.41	.21		.18	.03	.16	.01				.34	.66					1	
Przewalskiii				.30				.70			.09	.91	.23	.77			2	
Netherland horses:																	3	
Riding horse	.26		.53		.03	.08	.10				.32	.68			.14	.84	.02	3
Arab	.27		.44		.17	.11	.01				.51	.49			.10	.90		3
Trotter	.18		.61		.02	.13	.06				.43	.57			.08	.90	.02	3
Thoroughbreds:																		
Belgium	.31		.49		.07	.09	.04											4
Netherlands	.30		.44		.04	.13	.09											4
USA	.27		.56		.03	.09	.05											4
Hungary	.31		.47		.02	.10	.09											4
South Africa	.26		.55		.04	.07	.07											4
French	.31	.47			.04	.10	.07				.21	.79	.01	.99				5
French Riding Horse	.30	.46		.01	.10	.08	.04				.27	.73	.05	.95				5
Andalusian (Spain)	.36		.31		.20	.07	.01		.06		.58	.42	.15	.85				6
Lavradeiro	.27		.40		.08	.18	.07				.27	.73	.04	.96	.23	.77		7

References: (1) Gahne, 1966; (2) Bowling and Ryder, 1987; (3) Blokhuis and Buis, 1979; (4) Osterhoff *et al.*, 1974; (5) Kaminski and Nicolas, 1981; (6) Kaminski and Andres Cara, 1986; (7) Present work.

Although the present study is limited, especially by the small number of genetic systems analyzed and the lack of a more appropriate methodology for comparisons with results from other horse breeds, a stronger genetic relationship between the Lavradeiro and Thoroughbreds than was initially suspected by us is suggested. On the other hand, the relationship with the Andalusian (Iberic) breed appears to be greater than expected.

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RESUMO

Foram estudados os polimorfismos protéicos do sangue de 99 cavalos Lavradeiro do Estado de Roraima, Brasil, para determinar alguns aspectos da composição genética desta população. Quatro sistemas genéticos (transferrinas, albumina, fosfoglicomutase e anidrase carbônica) foram analisados e foram determinadas as frequências alélicas para quatro locos. A população mostrou estar em equilíbrio Hardy-Weinberg, exceto para a transferrina. A comparação dos dados obtidos com dados da literatura sugerem uma forte relação genética entre o cavalo Lavradeiro e os Thoroughbreds.

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