

HAEMOGLOBIN POLYMORPHISM IN BRAZILIAN NELORE CATTLE

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ABSTRACT

Haemoglobin variants were electrophoretically determined in 2,072 blood samples taken from adult animals of 8 different herds of Nelore cattle. Four migration bands were found: HbA, HbI, HbC, and HbB, but the last band may be possibly broken into two ones, named HbB₁ and HbB₂. The respective gene frequencies were 0.563 ± 0.012 , 0.007 ± 0.001 , 0.021 ± 0.002 , 0.188 ± 0.007 , and 0.221 ± 0.007 . The genotypic frequencies were in equilibrium. HbI has not been previously reported for Indian Zebu cattle.

INTRODUCTION

Haemoglobin variants have been extensively studied in Zebu cattle and at least 8 variants have been identified. In contrast to the large amount of information available for African and Indian cattle, relatively few papers, corresponding to surveys of limited size, have been published on the Hb variants of Brazilian Zebu cattle.

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The variability at this gene locus was investigated in the present study to provide information on the history and origins of Zebu cattle in Brazil.

MATERIALS AND METHODS

Blood samples were collected from 2,072 adult Nelore cattle in 8 herds located at Barretos, Ribeirão Preto, Cafelândia, Jaú, and Pereira Barreto, in the State of São Paulo. Blood was drawn from the jugular vein into heparinized plastic vials, and transported to the laboratory under refrigeration. Within a period of 24 hours after collection, the blood was centrifuged and the red cells washed three times in isotonic saline, before lysis of the cells in distilled deionized water and filtration. This material was immediately used, but in some cases it was placed in a freezer (-15°C) until electrophoresis was performed.

Starch gel electrophoresis was carried out using a discontinuous buffer system (Tris-citrate pH 8.6 in the gel, and sodium borate pH 8.0 for the bridge). Gel concentration was 13 g of starch (Connaught brand) to 100 ml of electrolyte. A current of 2 mA per sample was applied for the first hour of the run; the paper wicks used to insert the samples into the gel were then removed, and the current set to 4 mA per sample until the borate boundary reached the connection of the bridge. The gel was then cut horizontally and the bands were usually read without staining. In some cases Amido Black 10B (Merck) or Benzidine was used for staining.

RESULTS AND DISCUSSION

Five migration bands were found (Figures 1 and 2), each attributed to a single allele, with the following frequencies (Tables I and II):

Hb^A	=	0.563 ± 0.012
Hb^{B_1}	=	0.188 ± 0.007
Hb^{B_2}	=	0.221 ± 0.007
Hb^C	=	0.021 ± 0.002
Hb^I	=	0.007 ± 0.001

The Hb^A band, the slowest one, was considered to be similar to that observed by most authors since the original observations of Cabannes and

Table I - Frequencies of Hb alleles in Zebu cattle, as determined by several authors.

Breed	Location	No. of samples	Hb ^A	Hb ^B	Hb ^C	Hb ^D	Hb ^G	Hb ^I	Hb ^X	Hb ^{Khillari}	References
Afrikander	South Africa	165	0.852	0.064	0.084	-	-	-	-	-	Osterhoff and VanHeerden, 1965
Afrikander	South Africa	1428	0.819	0.064	0.117	-	-	-	-	-	Osterhoff, 1975
Afrikander	South Africa	940	0.734	0.168	-	-	0.098	-	-	-	Schwellnus and Guérin, 1977
Gyr	India	103	0.500	0.500	-	-	-	-	-	-	Lehman, 1959
Gyr	India	200	0.510	0.490	-	-	-	-	-	-	Naik <i>et al.</i> , 1965
Gyr	India	29	0.569	0.431	-	-	-	-	-	-	Sen <i>et al.</i> , 1966
Gyr	India	181	0.470	0.520	-	-	-	-	-	-	Singh <i>et al.</i> , 1972
Gyr	India	404	0.509	0.491	-	-	-	-	-	-	Naik <i>et al.</i> , 1969
Brahman	USA	182	0.541	0.448	0.011	-	-	-	-	-	Crockett <i>et al.</i> , 1963
Brahman	South Africa	620	0.498	0.494	0.008	-	-	-	-	-	Schwellnus and Guérin, 1977
Brahman	South Africa	155	0.577	0.400	0.023	-	-	-	-	-	Osterhoff, 1975
Kankrej	India	146	0.440	0.560	-	-	-	-	-	-	Singh <i>et al.</i> , 1972
Kankrej	India	69	0.540	0.460	-	-	-	-	-	-	Singh <i>et al.</i> , 1972
Kankrej	India	79	0.660	0.340	-	-	-	-	-	-	Singh <i>et al.</i> , 1972
Kankrej	India	343	0.587	0.410	-	-	-	-	0.003	-	Naik <i>et al.</i> , 1969
Ongole	Indonesia	55	0.646	0.327	-	-	-	-	0.027	-	Namikawa and Widodo, 1978
Ongole	India	124	0.780	0.220	-	-	-	-	-	-	Singh <i>et al.</i> , 1972
Sahiwal	India	44	0.625	0.375	-	-	-	-	-	-	Sen <i>et al.</i> , 1966
Sahiwal	India	45	0.570	0.430	-	-	-	-	-	-	Singh <i>et al.</i> , 1972
Nagouri	India	59	0.458	0.542	-	-	-	-	-	-	Dwaraknath and Joshi, 1971
Rathi	India	60	0.633	0.367	-	-	-	-	-	-	Dwaraknath and Joshi, 1971
Brahman	Australia	48	0.542	0.458	-	-	-	-	-	-	Brachmann <i>et al.</i> , 1978
Brahman	Venezuela	102	0.534	0.466	-	-	-	-	-	-	Pérez and Pérez, 1977
Gyr	Venezuela	9	0.278	0.722	-	-	-	-	-	-	Pérez and Pérez, 1977
Guzerat	Venezuela	4	0.625	0.375	-	-	-	-	-	-	Pérez and Pérez, 1977
Khillari	India	328	0.518	0.478	-	-	-	-	0.002	0.002	Naik <i>et al.</i> , 1969
Malawi	South Africa	57	0.623	0.255	0.096	0.026	-	-	-	-	Osterhoff, 1975
East African Zebu	Kenya	101	0.520	0.320	0.140	-	0.010	-	-	-	Braend, 1971

Table II - Frequencies of haemoglobin variants in Brazilian Nelore Cattle. Expected numbers in italics.

Phenotype	Herd										Total
	1	2	3	4	5	6	7	8			
HbA	54 87.48	47 42.16	62 47.87	32 39.62	202 238.04	192 158.48	35 22.19	25 20.92	649 656.76		
HbAB ₁	75 58.43	15 28.15	19 31.96	27 26.46	168 158.98	94 105.84	8 14.82	17 13.97	423 438.62		
HbAB ₂	56 68.68	42 33.10	50 37.57	42 31.10	193 186.88	130 124.42	16 17.42	9 16.42	538 515.61		
HbAC	16 6.53	3 3.14	—	1 2.96	24 17.76	5 11.82	3 1.66	5 1.56	54 49.00		
HbAI	9 2.18	—	1 1.19	—	10 5.92	—	—	—	20 16.33		
HbB ₁	19 9.76	4 4.70	4 5.34	4 4.42	34 26.54	13 17.67	2 2.47	7 2.33	87 73.23		
HbB ₁ B ₂	26 22.93	13 11.05	9 12.55	9 10.39	73 62.41	34 41.55	2 5.82	—	166 172.17		
HbB ₁ C	3 2.18	—	—	—	6 5.93	5 3.95	1 0.55	1 0.52	16 16.33		
HbB ₁ I	—	—	—	1 0.33	—	—	—	—	1 5.45		
HbB ₂	10 13.48	11 6.50	6 7.38	9 6.10	33 36.68	21 24.42	3 3.42	—	93 101.20		
HbB ₂ C	4 2.56	—	—	—	8 6.97	5 4.64	—	2 0.61	19 19.23		
HbB ₂ I	3 0.85	1 0.41	—	—	—	1 1.55	—	—	5 6.41		
HbC	—	—	—	—	—	—	—	—	—		
HbCI	—	—	—	—	—	—	—	—	—		
HbI	1 0.01	—	—	—	—	—	—	—	1 0.10		
TOTALS	276	133	151	125	751	500	70	66	2072		

Serain (1955). The band that immediately follows it was identified as the HbI of Schweltnus and Guérin (1977), and the one subsequent to it was taken as the HbC found by several authors in Asiatic cattle. This determination was performed with a standard kindly supplied to us by Dr. Guérin.

Schweltnus and Guérin (1977) proposed a hypothesis by which HbI would be specific to native African cattle, while HbC would be specific to Indian Zebu. It has been observed in this respect that the HbC found in Asiatic cattle is not the same as that reported by some authors for African cattle (Braend, 1971; Sang-Kee and Suzuki, 1976), and therefore it may be possible that the HbC identified by Osterhoff (1975) in native African cattle is in fact HbI.

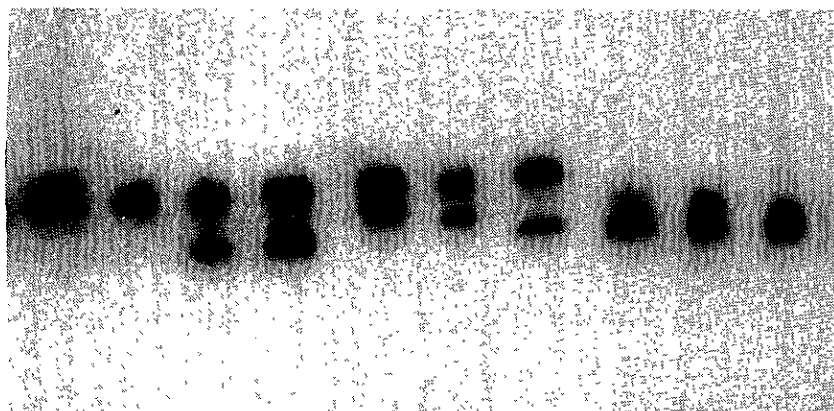


Figure 1 - Haemoglobin bands of Nelore cattle, after staining with benzidine. The phenotypes are, from left to right: HbB₁B₂, HbB₂, HbB₂A, HbB₂A, HbB₂C, HbB₂C, HbB₂A, HbA and HbA1.

These hypotheses, however, do not explain our problem. As far as we know, Brazilian Nelore have not received any influence from African cattle. Therefore, except for the remote case of our HbI being a mutant, the hypothesis of Schweltnus and Guérin (op. cit.) is disproved and both HbI and HbC are present in Indian cattle. Finally, a band between HbC and HbA has been recently found in Holstein-Zebu crosses at São Carlos, Brazil (Mortari, personal communication).

With respect to the two fastest bands, HbB₁ and HbB₂, we found no reference in the literature. They may be artifacts caused, for example, by

freezing and thawing of the samples, but both bands appeared in the frozen as well as in the fresh samples, always for the same animals. An explanation, though not entirely satisfactory, might be that the buffer system we used has been rarely used by other authors for Hb determination.



Figure 2 - Schematic representation of haemoglobin bands, as observed in Nelore cattle.

The gene frequencies we observed for the Hb locus do not agree with those determined for the Ongole breed by Namikawa and Widodo (1978) and Singh *et al.* (1972). These authors have obtained the following figures: 0.646 and 0.327, and 0.780 and 0.220 for Hb^A and Hb^B , respectively. If we pool the data for Hb^{B1} and Hb^{B2} , we obtain the following values: 0.563 and 0.409, without accounting for the other alleles. It should be remembered that the Ongole breed is the Asiatic counterpart of our Nelore. On the other hand, relatively few data have been analyzed by the cited authors, with the exception of Osterhoff (1975) and Schweltnus and Guérin (1977).

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RESUMO

Variantes hemoglobínicas foram determinadas em 2.072 animais Nelore pertencentes a 8 rebanhos de 5 municípios do Estado de São Paulo, sendo 5 alelos possíveis,

Hb^A , Hb^{B_1} , Hb^{B_2} , Hb^C e Hb^I , cujas frequências foram respectivamente $0,563 \pm 0,012$; $0,188 \pm 0,007$; $0,221 \pm 0,007$; $0,021 \pm 0,002$ e $0,007 \pm 0,001$. As bandas Hb^{B_1} e Hb^{B_2} observadas são bastante próximas entre si e ocupam a posição aproximada da Hb^B referida pela maioria dos autores. A Hb^I é encontrada pela primeira vez em zebrinos de raças indianas, tendo sido identificada anteriormente apenas em raças africanas.

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