

## SOME GENETIC MARKERS IN THE BLOOD OF THE BALKAN GOAT

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*The purpose of this paper was to describe the electrophoretic variants of genetic markers in red cells of the Balkan goat. The biochemical variation of five genetic markers: hemoglobin (Hb), nucleoside phosphorylase (NP), X-protein (X), malic enzyme (ME) and carbonic anhydrase (CA) was analyzed by starch gel electrophoresis.*

*The characteristic gene frequencies of the investigated Hb, NP, X and ME protein systems were established as: Hb<sup>A</sup> and Hb<sup>B</sup> (0.909 and 0.091); NP<sup>H</sup> and NP<sup>L</sup> (0.400 and 0.600); X<sup>+</sup> and X<sup>-</sup> (0.600 and 0.400); ME<sup>F</sup> and ME<sup>S</sup> (0.554 and 0.446) respectively. Carbonic anhydrase did not show polymorphism. The frequencies of these loci have been calculated for the native Balkan goat and compared with those for some goat studied by other authors.*

*Key words: Balkan goat, biochemical polymorphism, hemoglobin, nucleoside phosphorylase, X-protein, malic enzyme, carbonic anhydrase.*

### INTRODUCTION

There is a great number of studies in which biochemical polymorphism in the blood of sheep of different breeds all over the world, have been described. For goats, both, the number of studies, as well as the number of polymorphisms described, are substantially fewer than for sheep (Tucker 1975). Protein polymorphism in the blood of the native Balkan goat has not been investigated.

The Balkan goat is an indigenous breed traditionally reared in mountain regions of the Balkan peninsula, under very modest conditions, poor pasture and a sharp climate. The Balkan goat belongs to the European branch, as *Capra prisca adametz* is its ancestral origin. During the last few decades the number of animals has been decreasing, so the very existence of this indigenous breed is in danger (Buis 1983). This fact places a demand for conservatory work.

In order to assist the determination of the genetic constitution of the Balkan goat, the biochemical polymorphism of five genetic markers (Hb, NP, X, ME and CA) have been examined.

## MATERIAL AND METHODS

The animals used in this study belong to a Balkan goat population existing in the mountain regions of Montenegro. Blood samples were obtained from 132 goats and collected in heparinized tubes. Red cells were washed three times in saline solution and lysed with distilled water. The separation of blood proteins was carried out by horizontal starch gel electrophoresis following previously published methods: hemoglobin (Gahne 1960), nucleoside phosphorylase, X-protein and carbonic anhydrase (Tucker 1967) and malic enzyme (Baker 1977). The allele frequencies were computed by direct gene counting at the loci with codominant alleles, and from frequencies of the recessive homozygote for the simple dominant systems.

## RESULTS AND DISCUSSION

**H e m o g l o b i n.** Five different Hb types Hb A, Hb B, Hb D, Hb D-Malta, Hb E) have been detected in adult goats by electrophoretic and chromatographic techniques (Huisman 1970). The most common types, Hb A and Hb B, were segregated in the tested population. The gene frequencies (Table 1) found for the Balkan goat breed are not substantially different from those found in other goat breeds. Most of the goat breeds in the world are fixed for the H<sup>A</sup> allele: Saanen, Cambridge, Angora (Tucker 1983), Norwegian breed (Efremov 1965). The frequencies of the Hb<sup>B</sup> allele in Hungarian Saanen breeds are higher than those for most of the other breeds studied so far (Tucker 1975). Studies on the possible influence of Hb polymorphism on adaptive and reproductive traits of goats have not been done yet.

Table 1. Gene frequencies at several loci for Balkan goat

Locus	Allele		Frequency	
Hb	Hb <sup>A</sup>	Hb <sup>B</sup>	0.909	0.091
NP	NP <sup>H</sup>	NP <sup>L</sup>	0.400	0.600
ME	ME <sup>F</sup>	ME <sup>S</sup>	0.554	0.446
X	X <sup>+</sup>	X	0.600	0.400

**N u c l e o s i d e p h o s p h o r y l a s e.** Two types of NP have been described in the red cells of goats: NP H (high activity) and NP L (low activity) (Tucker 1980). According to the results shown in Table 1 it can be seen that the NP L phenotype is more frequent in the tested population. The published gene frequencies are only available for a few breeds. In all cases the NP<sup>H</sup> gene predominates. The Saanen breed is monomorphic in regard to the NP locus, showing the presence of the allele NP<sup>H</sup> (Tucker 1983).

In the tested population of Balkan goats, one blood sample differed from the common phenotypes. This phenotype showed electrophoretic activity only in the cathode region. No family data were accessible. This result should be interesting for further evaluation, since NP has an important role in purine metabolism.

**X - P r o t e i n.** Three different phenotypes of X protein have been described in goats: the X-negative type (X-) consists of two major bands, the X-positive type (X+) has one extra band (Tucker 1980), and the X-null type in which the three bands are absent (Barbancho 1984). X<sup>+</sup> and X- type were found in all breeds. In all cases the X<sup>+</sup> gene is predominant. X-null type was found only in Spanish breeds.

The physiological implication of X protein deficit is unknown as yet.

Compared with other goat breeds, the Balkan goat has a similar X gene frequency, as the Norwegian breed (Braend 1987) and breeds raised in Britain (Tucker 1983).

**M a l i c e n z y m e (M E)** The evaluation by starch gel electrophoresis revealed the presence of three common ME phenotypes controlled by two codominant alleles ME<sup>F</sup> and ME<sup>S</sup> (Baker 1977). The third allele ME<sup>C</sup> is segregated only in Spanish breeds (Rasero 1989).

Comparing the ME gene frequency of the Balkan goat (Table 1) with the ME gene frequencies of other goat breeds it can be concluded that the Balkan goat differs from them. The approximately equal frequencies of ME<sup>F</sup> and ME<sup>S</sup> genes (0.553 and 0.446) established in the Balkan goat enable the maximal number of heterozygous individuals. The Saanen goat breed is monomorphic in regard to the ME locus, showing the presence of the allele ME<sup>S</sup>. In other breeds the frequency of the ME<sup>S</sup> gene is greater than the ME<sup>F</sup> gene frequency.

**C a r b o n i c a n h y d r a s e (C A)** This locus did not show polymorphism in the tested population.

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## NEKI GENETSKI MARKERI U KRVI BALKANSKE RASE KOZA

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### SADRŽAJ

U radu su prikazani rezultati ispitivanja biohemijskog polimorfizma u krvi Balkanske rase koza u cilju boljeg poznavanja njene genetske konstitucije. Biohemijska varijabilost pet genetskih markera: hemoglobina (Hb), nukleozid fosforilaze (NP), X-proteina (X), maličnog enzima (ME) i karboanhidraze (CA) analizirana je elektroforezom na skrobnom gelu.

Za ispitivane proteinske sisteme Hb, NP, X i ME utvrđena je karakteristična frekvencija gena  $Hb^A$  i  $Hb^B$  (0.909 i 0.091);  $NP^H$  i  $NP^L$  (0.400 i 0.600);  $X^+$  i  $X^-$  (0.600 i 0.400) i  $ME^F$  i  $ME^S$  (0.554 i 0.446) prema navedenom rasporedu. Nije utvrđen polimorfizam karboanhidraze.

Izračunata frekvencija gena u ispitivanih lokusa Balkanske rase poređena je sa frekvencama gena drugih rasa koza.