

## GENETIC POLYMORPHISM OF BLOOD POTASSIUM IN GOATS BELONGING TO THE CARPATHIAN BREED

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### Abstract

*In the goats belonging to the Carpathian breed the genetic polymorphism at the determinant locus of blood potassium was revealed by the flame photometry method. The kalemic system in the Carpathian breed is characterized by a polymorphism of middle level due to the existence of the two phenotypes and of the three genotypes. The polymorphic character of this system is given by the distributional discontinuity of potassium ions in whole blood, the discontinuous space ranging between 16 mEq/l and 21 mEq/l. The animals with potassium ion concentration below the discontinuity space are of LK type, and those with ionic concentration above the discontinuity space are of HK type. The blood potassium level is determined by two alleles,  $K^L$  and  $K^h$ , being in incomplete dominance relationship; the allele  $K^L$ , responsible for low potassemia, is dominant compared to its recessive  $K^h$  allele which causes high levels of blood potassium. These two alleles at the Ks locus, located on an autosomal chromosome, determine three genotypes:  $K^L K^L$  (dominant homozygote),  $K^L K^h$  (heterozygote) and  $K^h K^h$  (recessive homozygote). In the Carpathian breed the allele  $K^h$  is more frequent (89.79%) than its dominant  $K^L$  (10.21%). The phenotype HK (80.62%) achieved a much higher frequency than the phenotype LK (19.38%). The recessive homozygotes recorded a high frequency (80.62%), the incidence of heterozygote's was moderate (18.34%), and the dominant homozygote were found sporadically in population. Consequently, the summed homozygosis for both types (81.66%) was much more present than heterozygosis (18.34%).*

**Key words:** blood potassium, genetic polymorphism, goat

### INTRODUCTION

The variability of potassium concentration in erythrocytes, depending on species, breed, individual, age, sex, physiological status, etc., was frequently reported in domestic animals by clinicians and physiologists, without specifying the limits of normal and pathological. In the same context, many studies have noted distributional discontinuity of potassium in the blood of animals, which has suggested that this chemical element presents polymorphism having genetic determinism.

The polymorphism of erythrocyte potassium was for the first time detected in sheep by Evans and King [4]. The existence of polymorphism for potassium in red blood cells or whole blood was confirmed in goat too, first reporting dating since 1957 [5].

In the caprine species, there have been reported some studies which reveal the similarity between sheep and goats under the aspect of genetic polymorphism of this action [8, 12, 13, 14, and 17]. Moreover, several studies have revealed, as well as in sheep, some associations between the biochemical polymorphism of potassium and various production traits [7].

The present paper has proposed to investigate the genetic structure at the determinant locus of blood potassium in the Carpathian breed goats. Information provided by this approach could be used in the programs of improvement and breeding of this goat breed.

### MATERIAL AND METHODS

Possible existence of polymorphous character of blood potassium in goats was experimented on a random population of the Carpathian breed from the *Research and Development Station for Sheep and Goat Breeding, Popauti-Botosani*.

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The blood samples were taken from animals by jugular venipuncture directly in tubes with heparin as an anticoagulant.

Determination of genetic variants of blood potassium was made using the flame photometry method.

*Preparing solutions necessary to carry out the flame photometry.*

a) *Samples for analysis.* Dilutions of 0.02% were made from whole blood samples of animals for determination of potassium ions by flame photometric dosing:

- whole blood ..... 0.1 ml
- bidistilled water ..... 5 ml

b) *Standard solution.* The flame photometer calibration was made with a pure solution of potassium chloride 5 mEq/l:

- potassium chloride ..... 0,3729 g
- bidistilled water ..... ad 1000 ml

*Flame photometric dosing.* The principle of this method is based on the "excitation" of potassium ions from blood by butane or acetylene flame produced by flame photometer, the result of this physicochemical process being the development of a potential that is recorded by the galvanometer needle of the apparatus. After flame photometer calibration with standard solution, the dilutions of whole blood were photometry, their extinctions being recorded. The cation concentrations of  $K^+$  in the whole blood of animals were expressed in mEq/l and were established depending on the extinction values on a calibration curve achieved from successive dilutions of the standard solution in the variability range from 5 mEq/l to 100 mEq/l.

*Detection of potassium phenotypes.* The identification of the blood potassium types was made depending on the cationic concentrations of potassium in whole blood of goats. The polymorphic character of blood potassium in goats is given by the discontinuous variability of its concentration distribution. The animals with ionic concentration of potassium below the discontinuity space are of LK type (with low potassemia), and those with ionic concentration above the discontinuity space are of HK type (with high potassemia).

The *allelic, phenotypic and genotypic frequencies (f)* of the potassium system were calculated according to incomplete dominance phenomenon by which the kalemic system is inherited.

## RESULTS AND DISCUSSIONS

In the Carpathian breed, the potassium ion concentrations in whole blood had a variability range between 6 mEq/l and 43 mEq/l. The discontinuity of potassemia distribution in this breed is found between 16 mEq/l and 21 mEq/l. As in sheep, the potassium concentration in whole blood showed a bimodal distribution. The potassium ion concentration distribution curve in whole blood divides the Carpathian goat population in two subpopulations: the goat subpopulation of LK type (Low Kalium) with low potassium levels and the goat subpopulation of HK type (High Kalium) with high potassium levels. Thus, the goats, whose blood potassium is between 6 mEq/l and 15 mEq/l, have the phenotype LK, and the goats, in which the blood potassium takes values between 22 mEq/l and 43 mEq/l, have the phenotype HK.

The heritage way of blood potassium in goats is similar to that described in sheep [5]. Consequently, both Kalium types in goats are genetically controlled by an autosomal locus with two alleles,  $K^L$  and  $K^h$ , the allele  $K^L$  being dominant to the allele  $K^h$  [5, 17]. According to the phenomenon of incomplete dominance, three potassic genotypes are expressed:  $K^L K^L$  (dominant homozygote),  $K^L K^h$  (heterozygote) and  $K^h K^h$  (recessive homozygote). Under the same principle, the dominant homozygote and heterozygote's belong to the phenotype LK, and the recessive homozygote has phenotype HK.

The Carpathian breed is characterized by the predominance of individuals with phenotype HK (80.62%); the individuals with phenotype LK have a moderate representation (19.38%) (Fig. 1).

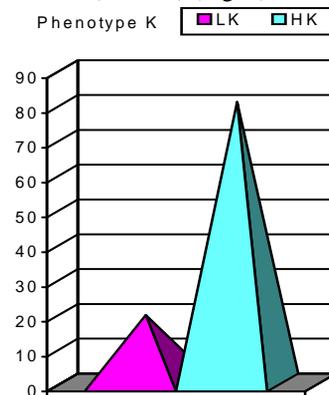


Figure 1. Phenotypic structure at the locus K in the Carpathian breed

In this breed, the two potassic alleles have a very unbalanced distribution, the recessive allele  $K^h$  having a very high spreading (89.79%) in comparison with its dominant  $K^L$  which has a low frequency (10.21%) (fig. 2).

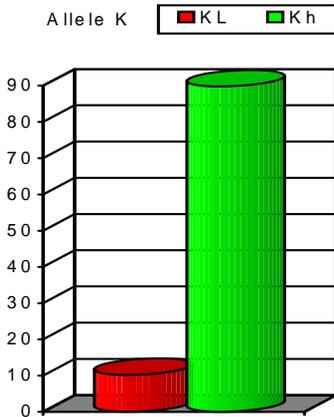


Figure 2. Allelic structure at the locus K in the Carpathian breed

As a result of this fact, the distribution of potassium genotypes is not also very uniform. The kalemic table is populated, to a large extent, by recessive homozygote  $K^hK^h$  (80.62%), while the dominant homozygote  $K^LK^L$  are very rarely met in the population (1.04%), and the heterozygous individuals  $K^LK^h$  recorded a moderate frequency (18.34%) (fig. 3).

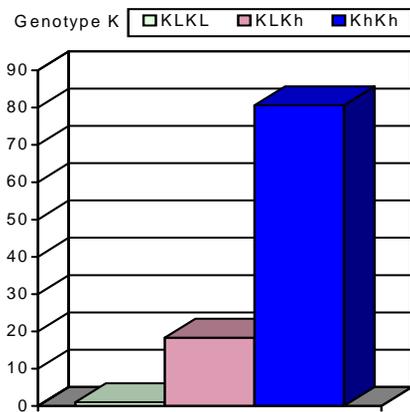


Figure 3. Genotypic structure at the locus K in the Carpathian breed

Therefore, on the total population too, the homozygosity for both types (81.66%) is much higher compared to the heterozygosity (18.34%) (fig. 4).

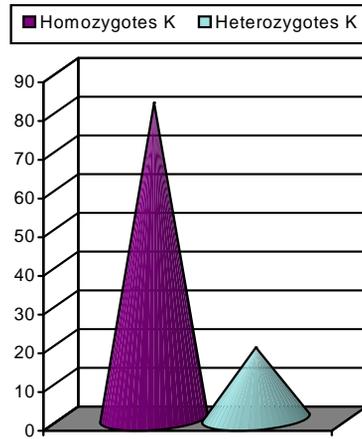


Figure 4. Zygosity status at the locus K in the Carpathian breed

The existence of two distinct levels of blood potassium ion concentrations is due to some biophysical and biochemical features of the Na/K-ATPase activity in the membranes of the two types of red cells, enzyme that uses energy derived from ATP hydrolysis to maintain intracellular potassium ions and to expel sodium ions. This phenomenon is possible because the ATPase enzyme is intimately involved in sodium-potassium pump mechanism from the level of cell membrane [16].

The goats represent the second species, after sheep, on the extent of potassium polymorphism investigation. In comparison with ovine species, in which, in most breeds, the phenotype LK is predominant [18], in the Carpathian goats the phenotype HK is widespread. Concerning the genetic structure at the K locus, the Carpathian breed goats are similar only to sheep belonging to the Botosani Karakul breed [9]. In fact, the predominance of phenotype HK is a constant feature in the whole caprine species [3, 7, and 17]. This characteristic is common also on the phylogenetic scale of species, it being found in the native goats too [19].

In the other species of domestic animals, this research field is almost nonexistent, only

a few summary reports being recorded, such as in cow [2, 10, 13], buffalo [15], yack [10, 11] and zebu [6] among mammals and in birds within the palmiped family [1]. This is because in these animals the kalemic polymorphism is very less obvious.

Potassium polymorphism in goats can be used as a selection tool for the genetic improvement of this species if the studies concerning the association/correlation of genetic structures of blood potassium with the production and reproduction traits, with the health status of individuals or with the resistance of animal body to environmental and technological factors require such approaches.

## CONCLUSIONS

1. The kalemic system in the Carpathian breed is characterized by a middle polymorphism due to the existence of two phenotypes (LK and HK) and of three genotypes ( $K^L K^L$ ,  $K^L K^h$  and  $K^h K^h$ ).

2. The phenotypic and genotypic structures of blood potassium are determined by the existence of two alleles which are in relationship of incomplete dominance, the allele  $K^L$  (responsible for low potassemia) being dominant compared to its recessive allele  $K^h$  (responsible for high potassemia).

3. In the Carpathian breed the allele  $K^h$  is more common in comparison with the dominant allele  $K^L$ ; the phenotype HK records a much higher frequency than the LK phenotype; genotypically, it comes out a high frequency of recessive homozygote ( $K^h K^h$ ), a moderate incidence of heterozygote ( $K^L K^h$ ) and a sporadic presence of dominant homozygote's ( $K^L K^L$ ).

4. The summed homozygosis of both types (dominant + recessive) is much more present than the heterozygosis.

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