

Full Length Research Paper

Genetic polymorphism of blood potassium in goat belonging to the different breeds in Mongolia

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Received 29 March, 2014; Accepted 24 October, 2014

In goats belonging to the different breeds and sub breed, the genetic polymorphism at the determinant locus of blood potassium was revealed by flame spectrophotometer method. The kalemic systems in those breeds were characterized by a polymorphism of middle level due to the existence of the two phenotypes and of three genotypes. The polymorphic character of this system is given by the distributional discontinuity of potassium ions in whole blood; the discontinuous space range were 10-34 m eq/L in the Mongolian native, 0.38-20.3 m eq/L in the Govigurbansaihan and 10.27-15.8 m eq/L in the AltainUlaan breeds. The animals with potassium ion concentration below the discontinuity space are of LK type (with low potassium) and those with ionic concentration above the discontinuity space are of HK type (with high potassium). 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 potassium, is dominant compared to its recessive K^h allele which causes high levels of blood potassium. These two alleles at the K_s locus, located on an autosomal chromosome, determine three genotypes; dominant homozygote ($K^L K^L$), heterozygote ($K^L K^h$), and recessive homozygote ($K^h K^h$). In the Mongolian native breed, the allele K^h was less frequent (20%) than its dominant K^L (80%), in the Govi Gurban Saihan breed, and the frequency of the alleles were also 5 and 95%, respectively. The phenotype LK (80-100%) achieved a much higher frequency than the phenotype HK (5-20%) in those breeds. Consequently, the recessive homozygosis and heterozygosis recorded an equal frequency (50%, 50%) in the Mongolian native breed, and the frequency of recessive homozygosis were slightly higher than heterozygosis (66%>34%) in the Govi Gurban Saihan.

Key words: Blood potassium, genetic polymorphism, adaptation, goat.

INTRODUCTION

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 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 (Tucker, 1971).

The goats represent the second species after sheep, on the extent of potassium polymorphism investigation. In comparison with other species in which, in most breeds, the phenotype LK is predominant (Evans and King, 1955; Evans and Phillipson, 1957; Evans, 1954a; Taneja and Ghosh, 1965), in the Mongolian native, Govi Gurban Saihan breeds and Altai ulaan sub breed goats, the phenotype LK is widespread, so the results are not similar to some other studies in goat breeds (Hrinca, 2012; Hrinca and Vicovan, 1986). Although, this characteristic is also common on the phylogenetic scale of species. In the other species of domestic animals, this research field is almost nonexistent, and only a few summary reports have been recorded, such as for cow (Ellory and Tucker, 1970; Janchiv and Merkurieva, 1978; Komatsa et al., 2004), buffalo (Sengupta, 1974), yak (Janchiv and Merkurieva, 1978; Kamenek, 1977) and zebu (Evans, 1963) among mammals and in birds within the palmiped family. This is because in these animals the kalemic polymorphism is very less obvious. The variability of potassium concentration in erythrocytes and whole blood, 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 ones.

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 (Ellory and Tucker, 1970; Erkoç et al., 1987; Evans and Phillipson, 1957; Evans, 1954b; Moradi Shahrabak et al., 2011; Mostaghni, 2004; Kamenek, 1977; Hrinca, 2012; Sengupta, 1974; Tucker 1971). The present paper proposed to study the goats' adaption ability in Mongolian dry harsh environment through revealing the genetic structure at the determination locus of blood potassium level in whole blood.

MATERIALS AND METHODS

The existence of polymorphous character of blood potassium in goats was investigated on a random population of the different breeds and sub breed from the distinctive regions in Mongolia. The blood samples were taken from animals by jugular venipuncture directly in tubes with heparin as an anticoagulant. The determination of genetic variants of blood potassium was made using the flame spectrophotometer of atomic absorption system (Shimadzu). For K determination, whole blood was diluted by distilled water in a

ratio 1:500.

Analysis of variance and correlations of blood potassium polymorphism between breeds were calculated by Data analysis in Excel program.

The 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 potassium) and those with ionic concentration above the discontinuity space are of HK type (with high potassium).

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

RESULTS

Each group consisted of 20 goats from Mongolian native, GoviGurbanSaihan andAltainulaanbreeds. The whole blood potassium concentrations ranged per group from 10-34, 0.38-20.3 and 10.27-15.8 m eq/L, respectively. The concentration distributions of blood potassium in goat populations are presented as a curve.

The curve shows that the goats could be divided into two subpopulations via LK having 0.38-18 m eq/L of K^+ and HK having 18.83 -34.09 eq/L of K^+ with mean of 6.193 ± 1.2 m eq/L of K^+ in the Govi-gurbansai Khan breed, 15.97 ± 1.12 m eq/L of K^+ in the Mongolian native and 13.56 ± 0.4 12 m eq/L of K^+ in the Altai ulaan breed goats (Figure 1).

The goat breeds are characterized by the predominance of group with phenotype LK (80-100%); the group with phenotype HK have a moderate representation (5-20%) (Figure 2). Their gene frequency obtained in the populations are given in Table 1. In those breeds, the two potassium alleles have a very unbalanced distributed. The recessive allele K^h having a very little spreading (5-20%) in comparison with its dominant K^L which has a high frequency (30-100%). As a result of this fact, the distributions of potassium genotypes are not also very uniform. Therefore, on the total populations too, the homozygosis and heterozygosis for both types were 50% in the Mongolian native breed; the homozygote (66%) was much higher compared to the heterozygote (34%) in the Govi Gurban Saikhan breed.

DISCUSSION

The polymorphism of erythrocyte potassium was for the first time detected in sheep by Evans and King (1955).

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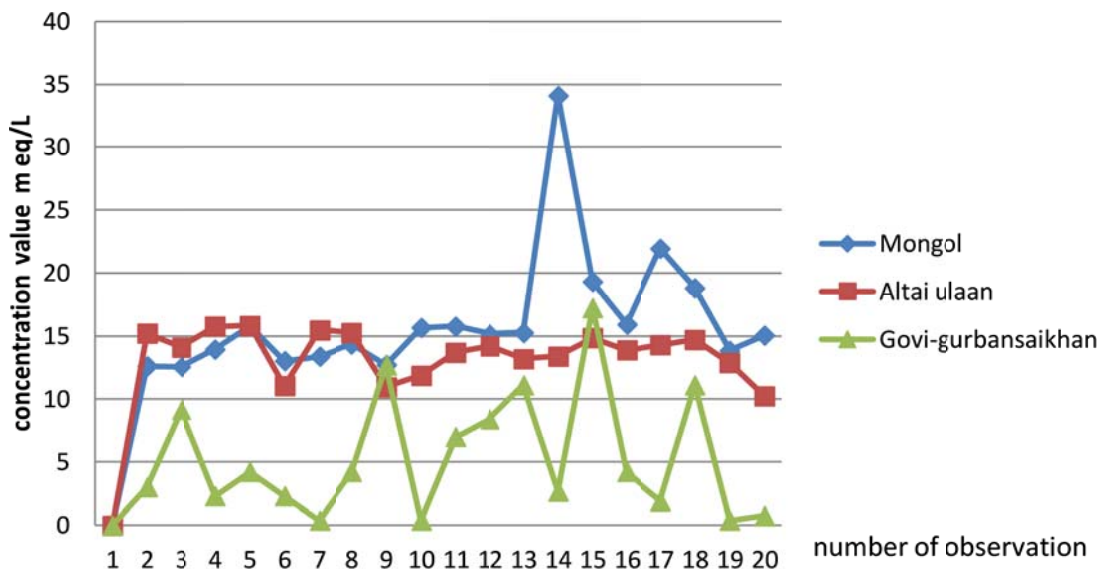


Figure 1. Concentration distributions of blood potassium in goats.

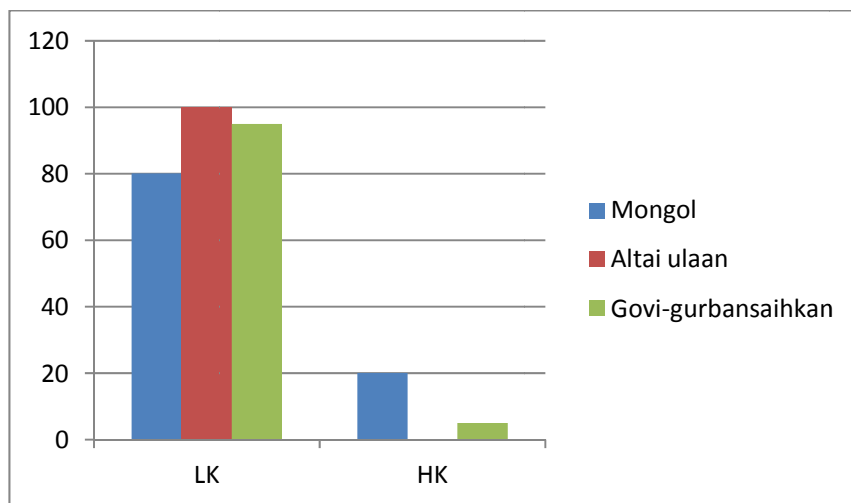


Figure 2. Phenotypic structure at the locus K in the different breeds.

Table 1. Determination gene and genotypes of blood potassium polymorphism.

Breeds of goat	Number of observation	Gene frequency (%)		
		K ^L K ^L	K ^L K ^h	K ^h K ^h
Mongol	20	30	50	20
Govi-gurbansaikhan	20	61	34	5
Altaiulaan	20	100	-	-

The existences of polymorphism for potassium in red blood cells or whole blood were confirmed in goat (Evans and Phillipson, 1957; Gurcan et al., 2011; Khan and

Taneja, 1983; Komatsa et al., 2004; Haba et al., 1991; Panon et al., 1987; Zhang, 2007). Furthermore, several studies have reported, as well as in sheep, some

associations between the biochemical polymorphism of potassium; other blood electrolytes are involved in adaptation process (Moradi Shahrabak et al., 2011; Hrinca and Vicovan, 1986; Taneja and Ghosh, 1965). 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 structure of blood potassium with the production and reproductive traits, with the health status of individuals or with the resistance of animal body to environmental or adaptation factors require such approaches.

Conclusions

For the kalemic system the Mongolian native and Govigurbansaihan breeds were characterized by 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 $K^h K^h$).

In the Mongolian and Govi Gurban Saihan breeds the allele K^L is more common; phenotype HK recorded a less frequency than LK phenotype; genotypically, there were less frequency of recessive homozygosis ($K^h K^h$), a middle incidence of heterozygosis ($K^L K^h$) and high presence of dominant homozygosis ($K^L K^L$).

The summed homozygosis of both types (dominant +recessive) were equal with the heterozygosis in the Mongol native breed.

Therefore, it can be considered that Mongolian native and Govi Gurvan Saihan goats have a good ability in adaptation.

Conflict of Interests

The author(s) have not declared any conflict of interest.

ACKNOWLEDGEMENTS

We thank the laboratory of Feed analysis at the Research Institute of Animal Husbandry. We are also thankful to the international organization "ACT lab" of mining investigation for the analysis of blood samples.

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