INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560–8530/2006/08–6–763–765
http://www.fspublishers.org

Whole Blood Potassium Polymorphism and its Relationship with Other Blood Electrolytes of Kermani Sheep in Iran

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ABSTRACT

The whole blood potassium concentration has shown the bimodal distribution in sheep, which has been classified into LK and HK types; HK allele is recessive to LK with a single gene inheritance. This polymorphism showed different behavior in different environment, which could be due to adaptation process. This research was conducted on the kermani breed research station, which has been located in a dry climate with saline drinking water for animals. The whole Blood potassium concentration of 188 animals ranged from 8 - 44 m eq/L. The curve that the sheep could be divided into two subpopulation *Via* LK having 8 - 18 m eq/L of K^+ and HK having 23 - 44 m eq/L of K^+ with mean of 12.086 ± 0.2 m eq/L of K^+ in the LK type and with mean of 32.614 ± 0.5m eq/L of K^+ in the HK types. The frequency of HK gene was found to be 0.902. Concentration of sodium, calcium in whole blood were also determined, the mean and range of blood sodium concentration were 1737.36 and 343-5000.04 ppm, respectively. The relationship between potassium and sodium concentrations in whole blood of sheep was significant. And negative estimated phenotypic correlation around -0.19, which was significant. The mean of whole blood sodium concentration was 3020.9 PPM and 2672.5 PPM for LK and HK, respectively. Remarkable differences in calcium and magnesium concentrations were not recognized between LK and HK types.

Key Words: Potassium polymorphism; LK; HK; Kermani sheep; Electrolytes

INTRODUCTION

Evans and co-workers (Evans & King, 1955; Evans *et al*., 1956; Evan & Mounib, 1957; Evans *et al*., 1958; Evans, 1968) have shown that sheep of the same breed fall into two classes with respect to the K concentration within their red blood cells (R.B.C.S). The majority of individuals have low K (L K) cells and a minority has high K (HK) cells (Evans & Mounib, 1957) although the proportion of LK to HK animals may vary considerably between different breeds (Evans *et al*., 1958). The authors presented convincing evidence for the claim that the cell type is genetically determined and that the genetic pattern can well be explained by the simple assumption of a single pair of alleles, the gene for LK being dominant over the gene for HK. several investigations have elucidated the physiological basis for the difference in R.B.C. K and (Na) content (Sheppard *et al*., 1951; Joyce & Weatherall, 1958; Tosteson & Hoffman, 1960; Tosteson, 1963, 1966, 1967, 1969) the salient feature seems to be a high number of Na _K pump sites per unit cell membrane surface in HK cells and a low number in LK cells (Dunham & Hoffman, 1969; Hoffman, 1969; Lauf *et al*., 1970). In addition, Tosteson and Hoffman (1960) found that the permeability of the membrane towards K and Na is different in the two cell types. The question as to whether there exist kinetic differences in the system for active cation transport in the two cell types is as Yet under discussion (Hoffman & Tosteson, 1969; Tosteson, 1969; Whittington & Blostein, 1971). In certain goat breeds a similar dimorphism with respect to alkali cation content of red cells was found (Evans & Phillipson, 1957).

In cattle the alkali cation content of R.B.C.S is less well known. A study on Ayrshire cattle suggested that only on type of animals with LK cells (with a mean value of 20 m-mole/L. cells and a range from 12 to 39 m-mole/L. cells) can be found (Evans & Phillipson, 1957), although the contention exists that a bimodal distribution is universally encountered in ruminants (Evans, 1968). We therefore decided to study the problem using Swiss cattle breeds. The survey included mainly animals of the Simmenthal breed but also a few Swiss brown (braunvieh), Swiss black spotted (Freiburger Schwarzfleckvieh) and others. Since analysis of the results revealed no difference between breeds, the figures from all animals tested were pooled. An attempt was made to describe quantitatively the differences in passive permeability, Na - K pump activity and Na + K activated membrane ATP ase by measuring net cation fluxes in cold, net cation fluxes at 37°C and phosphate liberation from ATP by isolated membranes. This paper describes the genetic polymorphism of potassium level and its relationship with other blood electrolytes in Varamini Sheep in Iran.

MATERIALS AND METHODS

This study conducted in the Kermani Research station that located in the shahrbabak –Iran. The material for the present study consisted of 188 sheep. Since it is known that LK sheep and cattle are born With High R.B.C. K-concentration, which falls to a low steady level during the first weeks of life (Wise Caldwell *et al*., 1947; Widdas, 1954; Wright *et al.*, 1958; Tosteson & Moulton 1959; Evans & Blunt, 1961; Blencher 1961; Tosteson, 1966) only animal above 4 months of age were used. Climate conditions and feeding habits were approximately similar for all animals tested.

Sheep were selected randomly and blood was collected into heparinized vials as anticoagulant and from the jugular vein and brought to the laboratory in an ice cooled isolating box.

Determination of potassium and blood electrolytes (Na, Ca & Mg) was carried out by using a spectrophotometer of atomic absorption system (shimadzu). Evans *et al.* (1956) and Khattab *et al.* (1964) have reported the plasma concentration to be same in both LK and HK sheep and the differences in whole blood potassium was attributed to the difference in red blood cell K^+ concentration. Hence only the Whole blood K^+ concentration was estimated in the present study and this was taken as reflecting the K^+ concentration in the erythrocytes.

Since potassium is the cation of Intracellular and there is in the erythrocytes, the erythrocyte must be lyses for measurement of potassium. For K determination whole blood were diluted with water distiller and we diluted of 0.1 mm of sample in ratio 1:500 and then potassium concentration in the whole blood was determined in the spectrophotometer of atomic absorption system (shimadzu).

For Na determination whole blood were diluted with water distiller and we diluted of sample in ratio 1:4500 and then sodium concentration in the whole blood was determined in the spectrophotometer of atomic absorption system (shimadzu).

For Mg (magnesium) and Ca (calcium) determination, whole blood were diluted with water distiller and it's diluted of sample in ratio 1:30 and then sodium concentration in the whole blood was determined in the spectrophotometer of atomic absorption system (shimadzu).

Concentration of the electrolytes in the whole blood was determined by the spectrophotometer of atomic absorption system (shimadzu) in ppm and then unit concentration (ppm) of potassium convert to meq/L for determination of polymorphism.

Frequency of gene and genotype of whole blood potassium polymorphism were calculated by collected data and then LK and HK samples were determined by curve normal distribution (bimodal distribution has showed two phenotype in whole blood potassium & we can separate these phenotypes) (Suzuki, A. *et al.*, 1991).

Analysis variance and correlation of blood potassium polymorphism with other electrolytes were calculated by GLM in SAS program, respectively.

Phenotypic correlations between potassium concentration and other electrolytes were calculated by Pearson method in correlation procedure in SAS program.

RESULTS

The whole Blood potassium concentration of 188 animals ranged from 8 - 44 m eq/L. The frequency distribution of blood potassium concentration in the sheep population is presented as a frequency curve. It is seen from the bimodal nature. The curve that the sheep could be divided into two subpopulation *Via* LK having 8 - 18 m eq/L of K^+ and HK having 23 - 44 m eq/L of K^+ with mean of 12.086 ± 0.2 m eq/L of K^+ in the LK type and with mean of 32.614 ± 0.5 m eq/L of K^+ in the HK types. The bimodal nature seen in the study is in agreement with that observed by Evans (1954), Evans and Mounib (1957), Pater and Suska (1962), Meyer (1963), Khattab *et al.* (1963).

The frequency distribution of LK and HK phenotypes and their gene frequency obtained in the population are given in Table I. It was seen that 81.38% of kermani sheep are of HK type, while 18.62% are of LK type. The frequency of HK gene was found to be 0.902 (Table I). Concentration of sodium, calcium and magnesium in whole blood were also determined, the mean and range of blood sodium concentration were 1737.36 ± 32 ppm and 343 - 5000.04 ppm, respectively. The relationship between polymorphism of potassium and sodium concentration in whole blood of sheep was different significant ($P < 0.001$) with negative estimated correlation of -0.19 ($P < 0.001$) (Table IV). The mean of whole blood sodium concentration was 3020.9 ± 43 ppm and 2672.5 ± 38 ppm for LK and HK, respectively and this difference is significant ($P < 0.001$) (Table II).

Remarkable differences significant in whole blood of calcium and magnesium concentrations were not recognized between LK and HK types ($P > 0.05$) (Table III).

Inheritance of K types. The frequency of K types among the offspring born of different LK and HK mate are furnished in Table V. It is seen that HK* HK mating always resulted in HK offspring. It is in agreement with the finding of Evans and Kings (1955), Evans *et al.* (1956) (Table V).

DISCUSSION

Although the HK allele is recessive allele but frequency of HK allele is 0.9 because the climate condition in this region is dry with saline drinking water and HK gene is resistant allele for dry climate. In the literature showed that animals with HK phenotype have active Na-k-pump (i.e. concentration of Na & k in cell regulate with consume energy) but the animal with LK phenotype, concentration of Na and K regulate with simple diffusion and Na-K-pump is semi active. The relationship between potassium polymorphism and whole blood sodium concentration is negative. The animal with LK type have a high level of sodium but the animal with HK type Have a low level of sodium and this result return to performance of Na-K-pump activity that discussed above. Because this environment has been located in a dry climate with nearly saline drinking water and the animal with HK phenotype have active Na-K-pump. Therefore to regulate of Na K concentration in cell, the animal with HK genotype can better survive in this environment.

Table I. Determination gene and genotype of blood potassium polymorphism

Phenotype	Number of observation	% observation	Gene frequency
HK	153	81/383	(HK) 0.902
LK	35	18/617	
Total	188	100	

Table II. Comparison of Duncan's mean of Na within potassium types of Kermani sheep

Phenotype	number	Means (ppm)
LK	35	3020.9[a]*
HK	153	2672.5[b]

* The different letter show the significant different (P<0.01)

Table III. Comparison of Duncan's mean of Ca (calcium) and Mg (magnesium) within potassium types of Kermani sheep

Phenotype	number	Ca Means (ppm)	Mg means (ppm)
LK	35	56.83[a]*	25.71[a]
HK	153	55.85[a]	28.22[a]

* The same letter show the non significant different (P<0.05)

Table IV. Phenotypic correlations between potassium concentration and other electrolytes

Electrolytes	Ca (ppm)	Na (ppm)	Mg (ppm)
coefficient correlation	-0.04	-0.19	-0.11
level of significant	0.55	0.009	0.12
number of sheep	188	188	188

Table V. Result blood potassium polymorphism of progeny

Ram phenotype	×	Ewe phenotype	Progeny phenotype	
number		number	number	sex
HK (600*)	×	HK(878)	HK(2019)	female
HK (600)	×	HK(878)	HK(2121)	male
HK (600)	×	HK(1237)	HK(2149)	female
HK(1091)	×	HK(1441)	HK(2144)	female
HK(1091)	×	HK(1276)	HK(2139)	male
HK(804)	×	LK(1221)	HK(2158)	female
HK(1110)	×	LK(1335)	HK(2147)	female
HK(739)	×	LK(1142)	HK(1952)	female

* The number of animal in pedigree

Acknowledgement. We thank the Kermani sheep Research station in the Shahrbabak and the University of Tehran. We are also thankful to the Mr. Eng. mahmudi (The dean of Department animal science of Jihad-Keshavarsi organizer in Kerman), saburi, meymandinia and massumi (Department animal science of Jihad-Keshavarsi organizer in Shahrbabak).

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(Received 13 February 2006; Accepted 24 May 2006)