DESERT

DESERT
Online at http://jdesert.ut.ac.ir

DESERT 14 (2009) 95-99

Association of the whole blood potassium polymorphism with resistant to saline in two sheep breeds of different climates of Iran

H. Moradi Shahrbabak[a*], M. Moradi Shahrbabak[a], H. Mehrabani Yeganeh[a], Gh. Rahimi[b]

[a] *Department of Animal Science, University College of Agriculture & Natural Resources, University of Tehran, Karaj, Iran*
[b] *Department of Animal Science, Sari Agricultural Sciences and Natural Resources University, Sari, Iran*

Received: 26 December 2008; Received in revised form: 20 January 2009; Accepted: 13 February 2009

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 Zel and kermani breed research station, which Kermani breed Research Station has been located in a hot and dry climate with saline drinking water for animals and Zel breed research station has been located in a humid climate with normal drinking water for animals. Kermani breed Sheep: The whole Blood potassium concentration of 188 animals ranged from 8 - 44 m eq/l. The curve of shown 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. Zel breed Sheep: The frequency distribution of blood potassium concentration in the sheep population is presented as a frequency curve. It is seen from the monomodal nature. The curve that the sheep couldnt be divided into two subpopulation and all of animal has shown LK genotype. Blood potassium concentration ranged from 183.15 to 480.1ppm in Zel sheep and the Mean value of blood potassium concentration of Zel LK Animals was 277.37 and all of the zel animal were LK The ferquency of LK gene was found to be close to 1 in Zel sheep.The relationship between potassium and sodium concentration in whole blood of sheep was significant. And negative estimated correlation around –0.35 which was significant. The mean of whole blood sodium concentration was 2806/1 ppm for LK sheep. animals with HK phenotype have active Na-k-pump (i.e. concentration of Na and 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 activeTherefore to regulate of Na and K concentration in cell, the animal with HK genotype can better survive dry climate with nearly saline drinking water.

Keywords: Potassium Polymorphism; LK; HK; Kermani sheep; Zel sheep; Electrolytes

1. Introduction

Evans (Evans & King, 1955; Evans, King, Cohen, Harris & Warren, 1956; Evan & Mounib, 1957; Evans, Harris & Warren, 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

* Corresponding author. Tel.: +98 261 2248082; Fax: +98 261 2246752.
E-mail address: hmoradis@ut.ac.ir

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 they simply 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, martin & Beyl, 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; see also Hoffman, 1969; Lauf, Rasmusen, Hoffman, Dunham, Cook, Parmelee & Tosteson, 1970). In addition, Tosteson & 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 presents of study on the genetic polymorphism of potassium level and its Relationship with other Blood Electrolytes in kermani Sheep in Iran.

2. Material and method

This study conducted in the Kermani Research station located in Shahrbabak, Zel breed sheep, which located in Sari Mazandran, the material for the study consisted of 250 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 (Widdas, 1954; Wise Caldwell, parrish, Flipse & Hughes, 1947; Wright, Bradley, nelson &Coghlan, 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, and 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 0.1mm 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/lit 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 and we can separate these phenotypes) (Suzuki and 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.

3. Results

3.1. Kermani sheep

The whole Blood potassium concentration of Kermani sheep 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 shown 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 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 1. It seen that %81.38 of kermani sheep are of HK type while %18.62 is of LK type. The frequency of HK gene was found to be 0.902 (Table 1).

Table 1. Determination gene and genotype of blood potassium polymorphism of Kermani sheep

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

Concentration of sodium, calcium and magnesium in whole blood were also determined, the mean and range of blood sodium concentration were 1737.36±32PPM 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 2).

Table 2. Phenotypic correlations between potassium concentration and other electrolytes of Kermani sheep

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

The mean of whole blood sodium concentration was 3020.9±43ppm and 2672.5±38ppm for LK and HK respectively and this difference is significant (P<0.001)(Table 3).

Table 3. 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 letters show the significant different (P<0.01)

Remarkable differences significant in whole blood of calcium and magnesium concentrations were not recognized between LK and HK types (P>0.05) (Table 4).

Table 4. 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 letters show the non significant different(P<0.05)

3.2. Zel sheep

The frequency distribution of blood potassium concentration in the sheep population is presented as a frequency curve. It is seen from the monomodal nature. The curve that the sheep couldnt be divided into two subpopulation and all of animal has shown LK genotype. Blood potassium concentration ranged from 183/15 to 480/1ppm in Zel sheep and the Mean value of blood potassium concentration of Zel LK Animals was 277/37 and all of the zel animal were LK

The ferquency of LK gene was found to be close to 1 in Zel sheep.The relationship between potassium and sodium concentration in whole blood of sheep was significant. And negative estimated correlation around –0.35 which was significant.

The mean of whole blood sodium concentration was 2806/1 ppm for LK sheep. (Table 5).

Table 5. phenotypic correlations between potassium concentration and other electrolytes of zel sheep

Electrolytes	Ca (ppm)	Na (ppm)	Mg (ppm)
coefficient correlation	0.17^{ns}	0.35^{**}	0.47^{ns}
level of significant	0.27	0.01	0.76

4. Discussion

Although the HK allele is recessive allele but frequency of HK allele in Kermani sheep is nearly 0.9 and for zel Sheep we cant see the HK genotype. the climate condition in Kerman region is dry with saline drinking water and the frequency of the Hk allele is further in dry climate and The LK allele found further in the normal and humidity climate . In the literature showed that animals with HK phenotype have active Na-k-pump (i.e. concentration of Na and 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 because the concentration of Na and K regulate with simple diffusion and Na-K-pump is semi active and they needn't regulate with active Na-k-pump but the animal with HK type Have a low level of sodium and the animal have to regulate the concentration of Na and K with active Na-k-pump (i.e. concentration of Na and k in cell regulate with consume energy) (for kermani sheep). Therefore to regulate of Na K concentration in cell, the animal with HK genotype can better survive dry climate with nearly saline drinking water.

Acknowledgement

We thank the Kermani sheep Research station in Shahrbabak and the University of Tehran. We are also thankful to the Mr. Eng. M. R. Meymandinia (Dep. Animal Science of Jihad-Keshavarsi Organization in Shahrbabak).

References

Campbell, E.H., J.C. Ellory and J.C. Gibson, 1998. Anti-L antibody and the regulatory phosphorylation cascade of Lk sheep red blood cell. J. Physiol.27b: 357-364

Christinaz, P. and H.J. Schatzmann, 1972. High potassium and low potassium erythrocytes in cattle. J. Physiol. 224: 391-406.

Dunham, P.B., 1976a. Two populations of antibodies affecting cation transport in LK erythrocytes of sheep and goats. Bioch. ET phyiol. ACTA. 443: 219-226.

Dunham, P.B. and R. Blostein, 1976b. Active potassium transport in reticulocytes of High-K^+ and Low-K^+ sheep. Bioch. Et Biophy. ACTA. 455: 749-758.

Dunham, P.B. and R. Blostein, 1997. L-antigens of sheep red blood cell membranes and modulation of ion transport. Am. J. Physiol. 272: 357-368.

Dunhom, P. B. and J. C. Ellory, 1981. Passive potassium transport in low potassium sheep red cells: Dependence upon cell Volume and chloride. 318: 511-530.

Ellory, J. C. and E. M. Tucker, 1970. Active potassium transport and the L and M antigens of sheep and goat Red cells. Bioch. Et. Blophy. ACTA. Vol.58: 160-168.

Evans, J.V., 1954. Electrolyte concentration in red blood cells of British breeds of sheep. Nature. Vol. 174. No. 4437: 931-932.

Evans, J.V., 1957. Water metabolism in the sheep. Nature. Vol. 180: 931.

Evans, J.V., H. Harris and F.L. Warren, 1958. Hemoglobin and potassium blood types in some Non-British Breeds of sheep and in certain rare British Breeds. Nature. Vol. 182: 320-327.

Evans, J.V., J.W.B. King., B.L. Cohen., H. Harris and F.L. Warren, 1956. Genetic of Hemoglobin and blood potassium differences in sheep. Nature. No. 4538: 849-850.

Evans, J.V., J.W. King, 1955. Genetic control of sodium and potassium concentration in the red blood cell of sheep. Nature. Vol. 176: 171-172.

Khan, M.S. and G.C. Taneja, 1983. Lk gene and wool production characteristics in rajasthan desert sheep. Indian. J. Anim. Sci. Vol. 53. No. 8: 898-901.

Khan. M.S., 1997. Biochemical model for sustained animal production in arid ecosystem. Central arid zone research Institute. 353-362.Indian.

Krishnamurthy. U.S. and V. Rathnasabapathy, 1977. Genetics of blood potassium in Nilagiri merino and their cross-bred sheep. Indian Vet. J. 54: 36-41.

Lipecka. C., M. Pieta and T. Gruszecki, 1991. Genetic polymorphism of blood potassium in various breeds and strains of sheep. Genetica polonica. Vol. 32. No. 3: 113-117.

Lipecka. C., M. Pieta and T. Gruszecki, 1994. The potassium level in the blood of sheep and their productivity. J. of Anim. And feed. Sci. Vol. 3: 89-96.

Moradi Shahrbabak H., M. Moradi Shahrbabak, G. Rahimi and A.Nikkhah, 2002.estimation of body weight traits (co)variance components and genetic parameters in kermani sheep and study of blood potassium polymorphism and its relationship with production trait. Thesis of M.SC. Department of animal science.University of Tehran.Karaj. IRAN.

Pittman, S.J., J.C. Ellory., E.M. Tucker and C.I. Newbold, 1990. Identification of a 25 Kda polypeptide associated with the L-antigen in low potassium-type sheep red cells. Bioch. Et Bioph. Acta. 1022: 408-410.

Reddy, V.R.C. and A.R. Krishnan, 1988. Blood potassium types and their relationship with body weight in sheep. Cheiron. Vol. 17, No. 3: 114-120.

Reddy, V.R., V.P. Padmanabha and K.K. Reddy, 1990. Distribution of Blood potassium types and their relationship with Growth traits in Nellore and Nellore X Dorset Half-Bred sheep. Indian Vet. J. 67: 420-424.

Singh, L.B., P.K. Dwarakanath., A. Rakim. V and S.P. Prasad, 1979. Blood electrolyte (K and Na) and Hb-Variants in karakul sheep. Indian Vet. J. 56: 554-556.

Suzuki, A., K. Sugawara, 1991. Frequency of appearance of low and high potassium types and mineral concentration in whole blood of sheep. Tohoku J. of Agri. Resea. Vol. 41. No. 3-4: 57-60.

Swenson, M.J. and W.O. Reece, 1996. Duckes physiology. book.PP:24-27.

Whittington, E.S. and R. BLOSTEIN, 1971. Comparative properties of high potassium and low potassium sheep erythrocyte membrane sodium activated adenosine triphosphatase. The J. of Biolo. Chem. Vol. 246, No. 11: 3518-3523.

Wright, R.D., T.R. Bradley., J.F. Nelson and J.P. Coghlan, 1985. Changes in the potassium concentration and metabolism of red blood cells of the lamb. Nature. Vol. 182. No. 4651; 1742-1743.

Wright, R.D., T.R. Bradley., J.F. Nelson and J.P. Coghlan, 1985. Changes in the potassium concentration and metabolism of red blood cells of the lamb. Nature. Vol. 182. No. 4651; 1742-1743.