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Polymorphism of Erythrocyte Potassium, Transferrin, Haemoglobin, Albumins and their Relationship with Several Milk Production Traits for Black and White Cattle in Turkey

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Blood protein polymorphism such as erythrocyte potassium concentration (Ke), albumin (Al), transferrin (Tf) and haemoglobin (Hb) of Black and White cattle breed raised in Turkey were investigated in this study. The genetic constitution of herd with respect to these loci were examined. The relationship between blood protein types and several milk production traits were investigated. Several milk production traits such as milk yield, average daily milk yield and lactation length were compared with blood protein types. The haemoglobin and albumin loci were found as monomorphic. The only Hb-AA and Al-BB genotypes were observed. The K^H and K^L gene frequencies of erythrocytes potassium concentration loci were found as 0.92 and 0.08, respectively. Six different genotypes in transferrin loci were found as Tf-AA, Tf-DD, Tf-DE, Tf-AE, Tf-AD, Tf-EE and allele frequencies of Tf-A, Tf-D, Tf-E were 0.26, 0.58 and 0.16, respectively. Some significant differences were found among the transferrin genotypes with milk production traits. The averege daily milk yield of Tf-AA genotype was different from Tf-AD genotype ($p < 0.01$) and Tf-DD genotype was different from Tf-AD genotype ($p < 0.05$). Milk yield of Tf-AA genotype was significant higher than those of Tf-AE, TF-AD genotypes ($p < 0.01$). Differences between two erythrocyte potassium concentration genotypes were not significantly important for the traits of milk production ($p > 0.05$). The genetic structure of animal for four loci were determined. Significant relationship was not found between milk production traits and genotypes except transferrin genotype.

Key Words: Blood protein polymorphism, Transferrin, Potassium, Haemoglobin, Albumin, Cattle.

INTRODUCTION

Improvement of domestic livestock for economically important trait is strictly dependent on selection of future breeding stock whose performance is better than the average population. In order to clarify that whether the level of future breeding stocks merit is above or below than that of average population, it is necessary to spent a time determined by generation intervals included the time necessary to obtain the performance records. To shorten this time required to this aim is depends to obtain indirect selection criteria such as blood protein biochemical polymorphic variants that can be determined easily and in the early stage of life. The genetic merit of parents for six-limited traits such as milk production is largely determined by evaluating their progeny. The value of such progeny test information depends on the accuracy of parentage records. To clarify the blood protein polymorphism of individuals are also beneficial tools for parentage test[1].

Firstly electrophoretic protein described was haemoglobin and transferrin polymorphism. They were used frequently used for parentage determination and indirect selection criteria for livestock species[2-15]. Blood biochemical polymorphism in domestic animal is used for parentage control, determining the type of twinning and estimating the genetic distance among the animal populations and it may be used as markers in relationship to productive characteristics[3]. The genetic causes of the relationship between blood groups and production traits were known as pleotropi, linkage and heterosis[2-4]. Some scientists believe that this relatioship may be possible with production and reproduction traits[5-8]. But some of them belive that this relationship is related with gene frequency of blood group or this relationship is not important for animal production[9].

Potassium is one of the intracellular elements consisting of organism's structure. The main function of potassium is to regulate the intracellular density of cells[10,11]. Some studies show that potassium and sodium concentration in blood are related with some economical yield traits for livestock animal[12-14]. Transferrin is a protein which transports the iron in the body and integrates this on the haemoglobin in the reticulosity. Other commonly studied proteins include albumin association of biochemical polymorphism markers with traits of economic importance was also a not attractive point of interest of scientist as a criteria of indirect selection.

Most of the studies have been done to determine blood protein polymorphism and to show it's relationship with production traits for different species and breeds population. Lozovoya and Soldotenkov[16], Bukataru and Moloshnyuh[17] have found a selective advantage for Tf-AA and Tf-DD genotypes for milk production. The otherwise Kliment and Novy[18], Samarineanu *et al.*[19] could not find any relationship between blood protein genotype and milk production traits.

The present study is aimed to investigate the polymorphism of blood proteins such as albumin (Al), transferrin (Tf), haemoglobin (Hb) and erythrocyte potassium concentration (K_e) of Black and White cattle breed that rose in Tahirova State farm. The genetic structures of animal with respect to these loci were examined. At the same time the relationship between blood protein types and some milk production characteristics that was obtained 532 lactation records were investigated.

EXPERIMENTAL

The research material was consisted of 532 production records of 155 Black and White dairy cows and their blood samples. Blood samples were taken into 20 mL sterilized and labelled vacum tube with anticoagulant (lithium heparin) from the *Venea Jugularis Externa*. Blood samples divided in two parts. One parts used for determination of potassium concentration. The other part used for transferrin, haemoglobin and albumin. For the analysis of Hb, Tf and Al whole blood was centrifuged at 3000 rpm for 10 min. Than red cell parts for Hb typing, plasma part for Tf and Al typing were seperated. Haemolysis was obtained by cleaning the red cell by 0.9 % physiological saline solution. Polyacrylamide gel electrophoreses (PAGE) was used transferrin polymorphism and analysis were determined according to Soysal[18], Anonymous[20] and Dogrul *et al*.[21]. Albumin and haemoglobin polymorphism were determined acoording to Dogrul[22] with horizontal starch gel electrophoresis. Erythrocyte potassium concentration polymorphism was determined by flame photometer according to the method's of Gonzales *et al*.[23]. Erythrocyte potassium concentration (Ke) below 46 meq/L types as low potassium (LK) and above 46 meq/L types as high potassium types (HK).

Gene frequencies were calculated with direct counting method for Tf and square root method for (Ke) types[24]. Due to low potassium alleles (K^L) was dominant to high potassium alleles (K^H). The deviation observed gene frequencies of examined loci from the expected frequencies under the assumption of genetic equilibrium were examined by Chi-square test[25].

Statistical methods: The variation of average daily milk year, lactation lenght, milk yield for milk production traits were investigated by least square analysis of SAS[26].

The following mathematical model was used:

$$Y_{ijklm} = \mu + I_i + YMLS_j + PF_k + b(SG_1) + e_{ijklm}$$

where every symbol standards for individuals production value, overall population μ = overall population mean, I_i = randomized effect individuals, $YMLS_j$ = fixed effect of calving season, number of lactation and production year, PF_k = fixed effect of blood protein genotypes, $b(SG_1)$ = regression of lactation lenght on production traits, e_{ijklm} = randomized distributed error.

The calving year was evaluated as production year for the 11 years of production records obtained (1989-2000). Four calving season were included such as every three month of year starting from previous year last month were considered as one group of seasons as spring, summer, autumn and winter. Five groups for number of lactation were included in the model. Lactation milk yields records were adjusted to Anonymous[27].

RESULTS AND DISCUSSION

Haemoglobin and albumin loci were found as monomorphic. The only Hb-AA and Al-BB genotypes were observed (A) allele gene frequency of haemoglobin loci and (B) allel gene frequency of albumin loci were determined as 1.0. The distribution of haemoglobin (Hb), transferrin (Tf), Albumin (Al) and erythrocyte potassium (Ke) phenotypes and their percentages are showed in the Table-1.

According to erythrocyte potassium types erythrocyte potassium and sodium concentration were showed Table-2. Erythrocyte potassium concentrations were found 68.05 meq/L and 37.75 meq/L for HK and LK genotype, respectively. Sodium concentrations were found 149.96 and 171.92 meq/L for HK and LK genotype, respectively.

TABLE-1
DISTRIBUTION HAEMOGLOBIN (Hb), ALBUMIN (Al), ERYTHROCYTE POTASSIUM (K_e) AND TRANSFERRIN (Tf) PHENOTYPES OF THE POPULATION

Loci	Hb			Al			Ke		Tf					
Genotypes	AA	AB	BB	AA	AB	BB	HK	LK	AA	DD	DE	AE	AD	EE
Number	155	–	–	–	–	155	122	22	13	61	18	14	41	8
Percentage (%)	100	–	–	–	–	100	84	16	8	40	12	9	26	5

TABLE-2
ERYTHROCYTE POTASSIUM AND SODIUM CONCENTRATION FOR HK AND LK TYPES

Genotypes	K_e (meq/L)	Na (meq/L)	N
HK	68.05 ± 1.26	149.96 ± 4.82	122
LK	37.75 ± 1.78	171.92 ± 10.24	22
General	63.56 ± 1.43	168.84 ± 4.42	144

The distrubution of allel frequencies with their standard errors of loci for Hb, Al, Tf, K_e are given in Table-3. The (K^H) and (K^L) alleles frequencies of erythrocyte potassium concentration loci were found as 0.92 and 0.08, respevtively. Six diffrent genotypes in transferrin loci were observed. These transferrin genotypes were as Tf-AA, Tf-DD, Tf-DE, Tf-AE, Tf-AD, Tf-EE. These genotypes were obtained from A, D, E alleles. The Tf^A, Tf^D, Tf^E alleles frequencies were determined as 0.26, 0.58 and 0.16, respectively. In present study, population is balanced in the Hardy-Weinberg equilibrium for Tf and Ke loci gene frequencies with Martinez[28], Babukov[29], Ronda[30].

TABLE-3
DISTRUBUTION OF ALLEL FREQUENCIES FOR HAEMOGLOBIN (Hb), ALBUMIN (Al), ERYTHROCYTE POTASSIUM (K_e) AND TRANSFERRIN (Tf) GENOTYPES

Loci	Hb		Al		K_e		Tf		
Alleles	A	B	A	B	K^h	K^L	A	D	E
Frequency	1.0	0.0	0.0	1.0	0.920	0.080	0.260	0.580	0.16
Standard error	–	–	–	–	0.015	0.015	0.024	0.028	0.20

Least square means with standard error for transferrin (Tf) and erythrocyte potassium (K_e) types concerning various production traits are given in Table-4. Fixed effect of calving season, number of lactation, production year and Tf genotyped were found very important factor to milk production traits ($p < 0.05$) but K_e gonotype was not found important statistically. Significant differences were found among the transferrin genotypes with respect to milk production traits. The average daily milk yield of Tf-AA (20.5 kg) were higher than those of Tf-AE (18.1 kg) and Tf-AD (17.7 kg) genotype, respectively ($p < 0.05$). Tf-DD (19.1 kg) was higher than Tf-AD (17.7 kg) for these trait ($p < 0.05$). The highest milk yield was obtained from Tf-AA genotype. The milk yield of Tf-AA genotype (6202 kg) was significantly higher than those of Tf-AE (5227 kg), Tf-AD (5368 kg) genotypes, respectively

TABLE-4
LEAST SQUARE MEANS WITH STANDARD ERROR FOR TRANSFERRIN (Tf) AND ERYTHROCYTE POTASSIUM (K_e) GENOTYPES CONCERNING VARIOUS PRODUCTION TRAITS

Loci	Genotype	N	Average daily milk yield (kg)	Milk yield (kg)	Lactation length (day)
K_e	HK	356	18.7 ± 0.4	5800 ± 159.6	320 ± 16.8
	LK	69	18.3 ± 0.8	5554 ± 295.5	319 ± 29.7
	General	425	18.6 ± 0.2	5760 ± 86.7	319 ± 10.8
Tf	Tf-AA	53	20.5 ± 0.7	6202 ± 270.0	316 ± 9.1
	Tf-DD	197	19.9 ± 0.4	5755 ± 148.0	302 ± 6.1
	Tf-DE	53	19.4 ± 1.0	5622 ± 256.0	334 ± 10.3
	Tf-AE	45	18.1 ± 0.9	5227 ± 270.0	286 ± 11.1
	Tf-AD	110	17.7 ± 0.5	5368 ± 184.0	303 ± 7.93
	Tf-EE	17	18.4 ± 1.4	5335 ± 428.0	311 ± 17.6
	General	475	19.1 ± 0.2	5635 ± 281.0	306 ± 3.3

($p < 0.01$). The lactation length of Tf-AA (316 day) was found significantly higher than Tf-AE (286 day) genotype ($p < 0.05$). Likewise Tf-DE (334 day) genotype was found important from Tf-DD (302 day), Tf-AE (286 day); Tf-AD (303 day) genotypes for this trait ($p < 0.01$). Present study could not find significant differences between two eriythrocite potassium types (HK, LK) in terms of milk production traits ($p > 0.05$). In spite of British and Spanish cattle breeds had been most commonly Al-AA types but present study had been all Al-BB so this results of regarding albumin type distribution were not same as the other result of researcher Spoonerand[31], Paguito-Gonzales *et al.*[32]. At the same time present study were found with similar results with Ozbeyaz *et al.*[33], also reported Al-B allel frequency was found 0.93 for Black and White cattle breed by Kamanek[34].

The distribution of Hb types were found similar with the most of the other results of Ozbeyaz *et al.*[35], Milovan and Granciu[36] also Hb-A allel frequency was found 0.99 and 1.0, respectively for Black and White cattle breeds.

The distribution of Tf types in general were in according of results of several other researchers Lozovoya[16], Dogrul *et al.*[21] reported that Tf-A ,Tf-D and Tf-E allel frequencies were 0.22, 0.66 and 0.12, respectively for the same breed. The highest milk yields were observed in the Tf-AA (6202 kg) and Tf-DD (5755 kg), respectively. Results were similar with the results of Lozovoya and Soldotenkov[16], Bukataru and Moloshnyuh[17], Korabaev[37] and Dogru[38] have found a selective advantage and important difference for TF-AA anf Tf-DD genotypes for milk yield. But Kliment and Novy[18], Samarineanu *et al.*[19] could not find any relationship between blood protein genotype and milk production traits.

Conclusion

Due to importance of relationship between transferrin types and production traits, the genetic structure of population was estimated for Hb, Tf, Al and K_e loci. No significant relationship was found between milk production traits and genotypes apart from transferrin loci. This loci may be used as index value to selection studies.

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