

Haemoglobin polymorphism and its effect on different economic traits of Garole sheep

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The Garole sheep is so far the only specialized sheep which is dwarf, highly prolific, has short lambing interval and is of coarse wool type. This sheep has specific characteristic of adaptability to hot and humid climatic conditions, grazing in knee-deep saline water and high mothering instinct for their neonates (Pan and Sahoo 2008). The genetically determined polymorphous system of haemoglobin in sheep provides an opportunities for using them as genetic markers that make it possible to conduct studies related to the genetic structure (Slavov *et al.* 2004). Although these genetic markers and their mode of inheritance were clarified in most sheep breeds, but for Garole sheep are rather limited. The objective of this research was to determine polymorphism of blood protein haemoglobin and also to determine the influences of haemoglobin on the performances of different economic traits of does.

Adult Garole sheep (48 ewes and 24 ram) were selected randomly from the University farm stock during the period from April-September 2008. Data on economic traits, viz. number of lambs produced in first, second, third, average number of lambs produce per lambing, age at first lambing (days) and lambing interval (days) of Garole sheep were collected from farm.

Blood samples were obtained by Jugular vein puncture, drawn into 5 ml tubes containing suitable anticoagulant. The blood was centrifuged at 6000 rpm for 15 min and the red cells were collected in a dry, aseptic glass vial and stored in deep freeze at about –20°C until used for electrophoresis. Electrophoretic examinations were done using a SDS-PAGE electrophoresis system for separating the hemoglobin types. Haemoglobin was typed by Andrew (1986). Identification of phenovariants was done on the basis of number of bands and mobility towards anode. Genotypes and gene frequencies

were estimated by direct counting method. The departure from genetic equilibrium was measured by Chi square test.

All statistical analysis was done by using the SPSS package. Effect of haemoglobin phenotypes on performance were analysed by least-square analysis of variance. The mean and standard error of the different economic traits under study were calculated and all tests for significance were done by following standard method.

Three different haemoglobin types (Hb AA, Hb AB and Hb BB) determined by 2 alleles (HbA and HbB) were observed. It was found that Hb A and Hb B are most common alleles among various alleles known to be responsible for haemoglobin types in sheep. Both the alleles (Hb A and Hb B) were found in this study. These two alleles control the inheritance of haemoglobin type and give rise to 3 phenotypes, namely Hb AA, Hb AB and Hb BB. It was found that 23 animals had AA phenotype, 32 animals with phenotype AB and 17 animals with BB phenotype in all the animals studied (Table 1). The more frequent phenotype was the heterozygous Hb AB phenotype animal that constituted about 45% of the total population. The other 2 phenotypes, HbAA and Hb BB animals were 32 and 23%, respectively. Similar results were also observed by Ghatak (2001) in Garole sheep and Bindu and Raghavan (2010) in Malabari goat.

Table 1. Genotype and gene frequencies of haemoglobin of garole sheep

Breed	Sample size	Genotype frequencies			Gene frequencies	
		Hb AA	Hb AB	Hb BB	Hb A	Hb B
Garole	72	0.319 (23)	0.444 (32)	0.236 (17)	0.534	0.465
Male	24	–	9.71% (7)	23.62% (17)	–	–
Female	48	31.95% (23)	34.72% (25)	–	–	–

Figures in the parenthesis indicate the number of sheep.

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In the present study the genotype and gene frequencies of haemoglobin for Garole sheep were calculated. The genotype frequency of Hb AA, Hb AB and Hb BB were 0.319, 0.444 and 0.236, respectively. In some exotic sheep for example, Lebrijan Churro breed of Andalusia, Rodero *et al.* (1996) reported phenotypic frequencies of 0.00%, 11.11% and 88.89% for HbAA, HbAB and HbBB, respectively, while the corresponding figures were 2.17%, 20.65% and 77.17% respectively for the Grazalema merino sheep. Bindu and Raghavan (2010) reported the genotype frequencies of 97.67% for Hb AA, 2.00% for Hb AB and 0.33% for HbBB in Malabari goat. The haemoglobin AB genotype was predominant in the studied Garole sheep population. On the other hand, haemoglobin BB genotype was predominated in different breeds of sheep as reported by Altinsa *et al.* (1995) in Sakiz breed of sheep and Ghatak (2001) in Garole sheep. The gene frequency of HB A and Hb B were estimated to be 0.534 and 0.465, respectively. It was observed that frequency of Hb A was higher than frequency of Hb B. Higher frequency of Hb A allele was also reported in Hungarian Merinos (Fesus *et al.* 1991), Turkis hair goat (Canatan *et al.* 2000), West African dwarf sheep (Bindu Akinyemi and Salako 2010) and Malabari goat (Raghavan 2010).

The difference between the frequencies of the 2 alleles can be used as a source of genetic diversity. On the other hand, higher frequency of Hb B was observed in many Indian and exotic sheep breeds as reported by Ukbev *et al.* (1990), Szczepanski *et al.* (1994), Altinsa *et al.* (1995) and Ghatak (2001). In the present study no female sheep with Hb BB was obtained. The absence of Hb BB genotype in Malabari goat was also reported by Bindu and Raghavan (2010). This may be due to sampling error as the sample size was very small. The absence of Hb BB genotypes in Hb loci had a selective advantage.

Calculated value of Chi-square (χ^2) is 0.956 for Garole sheep (Table 2). No significant differences could be obtained in Garole sheep between the observed numbers of animals belonging to the 3 different haemoglobin types and their expected numbers, calculated by Hardy-Weinberg Equation. The lack of considerable difference between the number of observed and expected haemoglobin genotypes indicated the genetic equilibrium of the population in the farm. Ghatak (2001) and Slavov *et al.* (2004) also showed that expected and observed value of haemoglobin locus were not significantly different, that herd is in balance for haemoglobin, similar to this study.

Table 2. Observed and expected number of haemoglobin genotype in Garole sheep

Types of haemoglobins	Hb AA	Hb AB	Hb BB	χ^2 (df =1)
Observed Genotype frequency	23	32	17	0.956
Expected Genotype frequency	20	36	16	

Number of lambs produced in first, second, third, average number of lambs produce per lambing, age at first lambing (days) and lambing interval (days) in 2 haemoglobin types (Hb AA and Hb AB) of Garole sheep are presented in Table 3.

Table 3. Least square mean, standard errors of different economic traits of garole sheep in respect of their haemoglobin genotypes

Traits	Groups		Overall mean $\pm$ SE
	AA genotype	AB genotype	
No. of lamb in first lambing	1.56 $\pm$ 0.14 (23)	1.36 $\pm$ 0.10 (25)	1.45 $\pm$ 0.08 (48)
No. of lamb in second lambing	1.43 $\pm$ 0.16 (23)	1.16 $\pm$ 0.22 (25)	1.29 $\pm$ 0.44 (48)
No. of lamb in third lambing	1.13 $\pm$ 0.27 (13)	0.96 $\pm$ 0.21 (8)	1.07 $\pm$ 0.25 (21)
Average no. of lamb per lambing	1.47 $\pm$ 0.04 (59)	1.29 $\pm$ 0.08 (58)	1.37 $\pm$ 0.06 (117)
Age at first lambing (days)	478.69 $\pm$ 7.65 (23)	476.40 $\pm$ 8.54 (25)	477.50 $\pm$ 5.71 (48)
Lambing Interval (days)	243.91 $\pm$ 20.50 (23)	170.40 $\pm$ 29.29 (25)	205.62 $\pm$ 19.07 (48)

Prolificacy: Garole sheep at this farm produced (Table 3), overall 1.37 $\pm$ 0.06 lambs per lambing. Sheep with Hb AA genotype showed better performance as compared to Hb AB genotype in respect to overall lambs production. Sheep with Hb AA genotype produced on an average 1.56 $\pm$ 0.14 lambs in first, 1.43 $\pm$ 0.16 lambs in second and 1.13 $\pm$ 0.27 lambs in third lambing. Whereas sheep with Hb AB genotype produced on an average 1.36 $\pm$ 0.10 lambs in first, 1.16 $\pm$ 0.22 lambs in second and 0.96 $\pm$ 0.21 in third lambing. Analysis of variance showed that haemoglobin polymorphism had nonsignificant effect on number of lamb born in lambing. Ghatak (2001) was also reported the similar report in Garole sheep for lamb production.

Age at first lambing (days): The overall mean of age at first lambing was 477.50 $\pm$ 5.71 days (Table 3). The mean of age at first lambing of Hb AA and Hb AB type sheep were 478.69 $\pm$ 7.65 and 476.40 $\pm$ 8.54 days, respectively. This result indicated that the mean value of age at first lambing between these 2 groups was almost same. In case of age at first lambing, the difference between haemoglobin types was statistically nonsignificant in Garole sheep (Table 3). Ghatak (2001) reported lower value for age at first lambing of Garole. As regards age at first lambing, the difference between haemoglobin types in 2 groups were found nonsignificant as the animals studied were all from the same herd. They had practically no variation in the age at first lambing within breed.

Lambing interval (days): Overall lambing interval was 205.62 $\pm$ 19.07 days in the herd of Garole sheep. The lambing interval was 243.91 $\pm$ 20.50 days for haemoglobin AA type group sheep and 170.40 $\pm$ 29.29 days for haemoglobin AB

type group sheep (Table 3). Lambing interval of Garole sheep was significantly ($P < 0.05$) affected by the haemoglobin type. Significantly higher value for lambing interval of Garole sheep was also reported by Ghatak (2001). Research result indicated that selection of sheep with Hb AB genotype is more profitable as these type had significantly lower days of lambing interval than Hb AA genotype sheep. Significant difference between 2 type genotypes of Garole sheep for lambing interval were observed, such occur might be due to variation in physiological effect on haemoglobin variants.

In conclusion, there was polymorphism in haemoglobin types in Garole sheep. According to the haemoglobin system there was genetic equilibrium. However, the presence of differences between the frequencies of the 2 alleles by categories could be a source of genetic diversity.

SUMMARY

The aim of this study was to determine the influence of polymorph systems of hemoglobin types on prolificacy, age at first lambing and lambing interval in Garole sheep. The haemoglobin type was controlled by 2 alleles (Hb A and Hb B) in Garole sheep. Analysis of variance showed that haemoglobin polymorphism had nonsignificant effect on number of lamb in lambing. The age at first lambing for Hb AA and HB AB were almost similar. The influences of haemoglobin types on lambing interval was significant. The highest lambing interval was obtained from Hb AA types whereas the lowest lambing interval was obtained from Hb AB types. In conclusion, there were polymorphism in haemoglobin types in Garole sheep. According to the haemoglobin system, population was in genetic equilibrium. However, the presence of differences between the frequencies of the 2 alleles by categories could be a source of genetic diversity.

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