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Haemoglobin, transferrin and serum alkaline phosphatase polymorphism in Kanni Adu breed of goats*

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Kanni Adu goat of Tamil Nadu is one among the documented Indian breeds of goats. The habitat, distribution and production of this breed had been studied (Thiruvenkadan *et al.* 2000) to establish the breed characteristics. However, no report is available on its characterization with genetic markers. Hence, an attempt was made to identify the presence of inherited biochemical variants of haemoglobin, transferrin and serum alkaline phosphatase based on their relative electrophoretic mobility and to characterize the breed with the genetic markers.

Heparinised blood samples were collected from 143 healthy Kanni Adu goats of both sexes (51 males and 92 females) belonging to different age groups and from 15 villages selected randomly in the breeding tract. The villages were located well apart forming a fair representation of the population and the breeding community.

The blood samples were processed and the plasma and haemolysate of red blood cells were prepared and stored at –20°C. Horizontal polyacrylamide gel electrophoretic technique (Gahne *et al.*1977) with minor modifications in the composition of electrode buffer was followed for typing haemoglobin variants. The technique adopted for the typing of transferrin variants was similar to that used for haemoglobin with the exception being the use of two different working gel solutions with 6 % and 12 % concentrations and gradient nature of the gel used as stacking gel and separating gel respectively. Serum alkaline phosphatase isoenzyme variants were typed by using horizontal polyacrylamide gel electrophoretic technique and the methodology was based on the procedure adopted by Smith *et al.* (1968, fide McLauchlen 1988). The gene frequencies for transferrin locus were carried out by direct counting method. The gene frequencies for serum alkaline phosphatase were calculated assuming the population to be in genetic equilibrium as there exists a dominant mode of inheritance.

The study revealed the existence of genetic polymorphism only in transferrin and serum alkaline phosphatase. Haemoglobin was found to be monomorphic in Kanni Adu goats.

Haemoglobin

In goats, 2 haemoglobin variants namely HB^A and HB^B were described of which HB^A was the most common. In Kanni Adu goats all the haemoglobin samples tested had similar electrophoretic mobility and moved on par with sheep haemoglobin type, HB^B which was used as control to identify goat HB^A in each electrophoretic run. Hence it was confirmed that all the goats were of HB^A type. The allele HB^A is fixed in Kanni Adu goats with a frequency of 1.0. Previous studies on haemoglobin variants in Beetal (Singh *et al.* 1977), Sirohi (Bhat 1986b), Chegu and Changthangi (Bhat 1987), Black Bengal (Baruah and Bhat 1980, Bhat 1986b, Panda and Patro 1987), and Pashmina goats (Menrad *et al.* 2002) also revealed the monomorphic nature of haemoglobin (HB^A). Even in reports demonstrating haemoglobin polymorphism in goats, the frequency of HB^A was considerably higher as 0.935 and 0.943 for Barbari and Jamnapari respectively (Joshi *et al.* 1975), 0.815 and 0.83 for Turkish hair goat (Canatan and Boztepe 2000, Elmaci 2003) and 0.98 for Saanen (Elmaci *et al.* 2006).

Transferrin

The distribution of different transferrin and serum alkaline phosphatase phenotypes and allele frequencies are presented in Table 1.

Three transferrin (TF) variants TF^A, TF^B and TF^C in five phenotypic combinations consisting of all the three homozygotes (TF^A, TF^B and TF^C) and two heterozygotes (TF^{AB} and TF^{BC}) were detected while TFAC was conspicuous

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Table 1. Distribution of phenotypes and frequencies of transferrin and serum alkaline phosphatase alleles in Kanni Adu goats

Serum protein/ enzyme	Pheno- type	Number*	Freq- uency	Allele frequency±SE
Transferrin	TF^A	15	0.105	TF^A 0.269±0.026
	TF^B	66	0.462	TF^B 0.675±0.028
	TF^C	1	0.007	TF^C 0.056±0.014
	TF^{AB}	47	0.329	
	TF^{BC}	14	0.098	
	TF^{AC}	0	0.000	
Serum alkaline phosphatase	ALP^F	71	0.497	ALP^F 0.290±0.027
	ALP^O	72	0.504	ALP^O 0.710±0.027

*Total number of animals tested for each protein/enzyme: 143

by its absence. The occurrence of 3 transferrin variants in Kanni Adu goats is in agreement with the earlier reports on Jamnapari (Bhat 1986b), Jhakrana, Kutchi, Marwari and Sirohi (Kumar and Yadav 1988), Turkish hair goats (Canatan and Boztepe 2000, Balcioglu *et al. 2005)* and Pashmina and Bakerwali goats (Menrad *et al.* 2002).

Among the Indian breeds of goats examined so far, all the breeds of the plains had TF^B at frequencies higher than those of the other alleles. The lowest frequency of TF^B reported so far was 0.550 for Malabari (Shamsuddin *et al.* 1988) while the highest frequency was 0.875 for Beetal (Singh *et al.* 1977). The gene frequency of 0.675 for TF^B estimated for Kanni Adu also reflects the same trend. However, a reverse trend was observed in Chegu, Changthangi and Pashmina goats with TF^A having higher frequencies than TF^B (Bhat 1987, Menrad *et al.* 2002). This could possibly be due to their habitat in high altitudes and different evolutionary origin.

The frequencies of TF^A varied from 0.105 for Kutchi (Kumar and Yadav 1988) to 0.473 for Barbari (Singh *et al.* 1977). The allele frequency of 0.269 for TF^A estimated in this study was closer to the estimates of 0.300 for Beetal (Trehan *et al.* 1981), 0.270 for Jamunapari (Baruah and Bhat 1980) and 0.290 for Marwari (Kumar and Yadav 1988). The third allele, TF^C had a low frequency of 0.056 in Kanni Adu. In other Indian breeds of goats also, TF^C when present, varied from 0.008 for Jamnapari (Bhat 1986b) to 0.219 for Jhakrana (Kumar and Yadav 1988). Absence of TF^C allele was also reported in native hair goats of Turkey and Sannan goats maintained in Turkey (Elmaci 2003, Elmaci *et al.* 2006). The chi-square test revealed that there was a significant ($P<0.05$) departure from the Hardy – Weinberg equilibrium frequencies. The heterozygosity at the transferrin locus was 0.469.

Serum alkaline phosphatase

Two different phenotypes of serum alkaline phosphatase, viz. ALP^F and ALP^O were observed. The ALP^F phenotype has both the faster migrating 'f ' zone and the slower migrating 's' zone, while the ALP^O phenotype had only the slower migrating 's' zone. The staining intensity of ALP^F phenotype was greater than that of the ALP^O phenotype, though there was a difference in staining intensity even among the samples having ALP^F phenotype. The frequency of ALP^O was much higher (0.710) than the frequency of ALP^F (0.290) allele. Previous reports on serum alkaline phosphatase polymorphism in Barbari, Jamnapari, Black Bengal, Chegu, Changthangi, Pashmina and Bakerwali breeds of goats also revealed the existence of only two phenotypes ALP^F and ALP^O with higher frequency for ALP^O allele (Bhat and Baruah 1980, Bhat 1986a, Bhat and Singh 1987, Menrad *et al.* 2002) as in the present study. However the frequency of 0.710 for ALP^O in Kanni Adu goats estimated in this study is the lowest among Indian goats reported. The estimated heterozygosity at the serum alkaline phosphatase locus was 0.412.

Characterization of Kanni Adu goats

Of the three biochemical marker systems analysed in Kanni Adu, none could lead to striking difference pointing to the genetic uniqueness of this breed. There were, however, some variations from the previous findings in other goat breeds on certain counts. The transferrin revealed the presence of the third variant TF^C which was not found in Malabari, (Shamsuddin *et al.* 1988) the only South Indian breed examined so far and also in Black Bengal (Baruah and Bhat 1980). The allele frequency of TF^B (0.675) in Kanni Adu was also higher than that of 0.550 for Malabari and 0.630 for Black Bengal. The frequency of the ALP^O allele (0.710) was the lowest among the five Indian breeds of goats examined so far, viz. Barbari, Jamnapari, Black Bengal, Changthangi and Chegu (Bhat and Baruah 1980, Bhat 1986a) though the difference was not much in terms of numerical values. Further studies utilising several genetic markers are needed for a better understanding of the genetic profile of Kanni Adu goats.

SUMMARY

Haemoglobin, transferrin and serum alkaline phosphatase polymorphism and the allele frequencies of variants in the Kanni Adu goats were studied by polyacrylamide gel electrophoresis. Of the three, only transferrin and serum alkaline phosphatase exhibited polymorphism and haemoglobin was found to be monomorphic with an allele frequency of 1.0 for HB^A. The study revealed the existence of three transferrin variants TF^A, TF^B and TF^C in Kanni Adu goats. Though six different combinations of phenotypes are possible only five phenotypes TF^A, TF^B, TF^C, TF^{AB} and TF^{BC} were detected. The estimated frequencies of TF^A, TF^B and TF^C alleles were 0.269, 0.675 and 0.056 respectively. Kanni Adu goats exhibited two serum alkaline phosphatase phenotypes, ALP^F and ALP^O and the frequencies of ALP^F

and ALP^O alleles were estimated to be 0.290 and 0.710 respectively. Based on the results Kanni Adu can be characterized by the predominance of TF^B variant and the presence of TF^C variant which has been reported in very few breeds of Indian goats.

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