

Erythrocyte Enzyme Variation in Brahmin and Rajput Populations of Himachal Pradesh. II. Solan District

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INTRODUCTION

As a part of a larger study plan on genetic variation in people of southern Himachal Pradesh (Sarin and Chahal, 2001), distribution of various erythrocyte (red cell) enzyme polymorphisms is reported here in the Brahmin and Rajput populations inhabiting Solan district. The main aim is to complete the molecular genetic map of this north-west Indian state.

SUBJECTS, MATERIALS AND METHODS

The subjects were not closely related local boys and girls attending Govt. Senior Secondary School, Kandaghat, Govt. Senior Secondary School, Chail and Govt. High School, Kalhog in Solan district of Himachal Pradesh. Finger-prick blood samples were collected in EDTA from 142 Brahmin and 160 Rajput caste students, selected at random. In the field, the samples were temporarily stored in a refrigerator and thereafter immediately transported personally in an ice-cooled thermocol box to Patiala in Punjab for their laboratory analyses.

Haemolysates made from blood samples were typed for phenotypes of as many as seven different erythrocyte enzyme polymorphisms viz. adenosine deaminase (ADA), adenylate kinase locus 1 (AK1), esterase D (ESD), phosphoglucomutase locus 1 (PGM1), acid phosphatase locus 1 (ACP1), glyoxalase locus 1 (GLO1) and glucosephosphate isomerase (GPI), following standard electrophoretic techniques (Murch et al., 1986; Wraxall and Stolorow, 1986; Wraxall and Emes, 1976; Scott and Fowler, 1982; Detter et al., 1968).

Using phenotype data allele frequencies of the studied enzyme systems were calculated by the gene counting method. Deviations, if any, from genetic equilibrium proportions in each system as also differences in various inter-population comparisons were checked for their statistical significance using the Chi-square test.

RESULTS AND DISCUSSION

The observed phenotype numbers alongwith the expected numbers (according to Hardy-Weinberg equilibrium) and Chi-square values for seeking significant differences between the two in each studied erythrocyte enzyme system among the Brahmin and Rajput populations of Solan district are presented in table 1. Table 2 shows the corresponding allele frequencies of these genetic systems. In no system was the goodness of fit χ^2 value large enough to attain statistical significance, suggesting genetic equilibrium within the either caste sample (Table 1). Furthermore, with a single exception of ADA ($\chi^2 = 6.7308$, d.f. 2, $0.5 > p > 0.02$), the other six erythrocyte enzymes showed homogeneous distribution between the Brahmin and Rajput samples of the district.

Comparative biochemical data from Himachal Pradesh are available for several Brahmin and Rajput subpopulations inhabiting various northern districts of the state (Bhasin et al., 1992; Singh et al., 1994) and a southern district reported recently in our earlier communication (Sarin and Chahal, 2001).

Table 1 shows that while all the three common phenotypes of the adenosine deaminase (ADA) system were found in the present Rajput sample of Solan district, the Brahmin sample lacked the least frequent type ADA 2. The ADA*2 allele showed a frequency of 0.0352 in the Brahmin and 0.0875 in the Rajput (Table 2). In the Brahmin samples reported earlier from Himachal Pradesh, the allele varied from as low as 0.049 in Kulu district (Bhasin et al., 1983) to 0.1171 in Shimla district (Sarin and Chahal, 2001). Similarly, among the Rajputs also the frequency recorded was rather variable, from 0.032 in the Gaddi-Rajput to 0.149 in the Rajput, both of Chuwari in Chamba district (Papiha et al., 1996). Clearly, while the frequency of the ADA*2 allele in the Rajput of Solan district was found well within the range

Table 1: Erythrocyte (red cell) enzyme phenotypes in the Brahmin and Rajput caste populations of Solan district (Himachal Pradesh)

System	Phenotype	Brahmin		Rajput	
		Observed number	Expected number	Observed number	Expected number
ADA	1	132	132.18	134	133.23
	1,2	10	9.65	24	25.55
	2	0	0.18	2	1.23
	Total	142	142.01	160	160.01
	χ^2	0.19		0.59	
AK1	1	123	121.78	133	134.14
	1,2	17	19.45	27	24.72
	2	2	0.78	0	1.14
	Total	142	142.01	160	160.00
	χ^2	2.25		1.36	
ESD	1	82	83.67	97	94.56
	1,2	54	50.66	52	56.89
	2	6	7.67	11	8.56
	Total	142	142.00	160	160.01
	χ^2	0.62		1.18	
PGM1	1	63	62.00	80	82.66
	1,2	60	62.33	69	63.97
	2	17	15.67	10	12.38
	1,3	1	0.66	0	0
	1,7	0	0.00	1	0.72
	Total	141	140.66	160	159.73
	χ^2	0.14		1.08	
ACP1	A	10	9.45	22	17.89
	A,B	50	53.07	60	69.55
	B	77	74.51	73	67.60
	A,C	3	1.04	3	1.67
	B,C	1	2.91	2	3.25
	Total	141	140.98	160	159.96
	χ^2	0.02		1.46	
GLO1	1	7	7.21	2	4.39
	1,2	50	49.58	49	44.22
	2	85	85.21	109	111.39
	Total	142	142.00	160	160.00
	χ^2	0.01		1.87	
GPI	1	137	137.05	157	157.01
	1,3	5	4.91	1	0.99
	1,5	0	0	2	1.98
	Total	142	141.96	160	159.98
	χ^2	0.00		0.00	

reported for this caste population of Himachal Pradesh, the present Brahmins recorded a value lowest so far encountered in them in the state. Compared with different other Brahmin subpopulations of Himachal Pradesh, the Brahmin sample of Solan district was found to be significantly different only from that of adjoining Shimla district ($\chi^2 = 12.87$, d.f. 2, $0.01 > p > 0.001$). On the other hand, the present Rajputs were found to be homogeneous with various other regional Rajput groups of the state for this enzyme system.

Incidentally, in the adenylate kinase locus 1 (AK1) system also, the less frequent phenotype AK1 2 was found lacking in one of the two samples tested from Solan district (Table 1). The frequency of the AK1*2 allele in the Brahmin and Rajput was found to be 0.0739 and 0.0844, respectively (Table 2). Earlier data on AK1 polymorphism among different Brahmin subpopulations from Himachal Pradesh reveal that the allele varied from 0.0721 in Shimla district (Sarin and Chahal, 2001) to 0.132 in Chamba town of Chamba district (Chahal et al., 1991). For

different Rajput subpopulations of the state, the frequency reported was from 0.055 in the Gaddi-Rajput of Palampur in Kangra district (Singh et al., 1982) to 0.113 in the Rajput of Churah of Chamba district (Papiha et al., 1996). Evidently, the *AK1*2* values for the present Brahmin and Rajput material fit well within their respective caste ranges observed in Himachal Pradesh and their Chi-square comparisons with various other regional Brahmin and Rajput groups of the state did not reveal any significant differences.

As for the esterase D (ESD) enzyme system, the present Brahmin and Rajput samples showed an *ESD*2* allele frequency of 0.2324 and 0.2313, respectively (Table 2). In Himachal Pradesh, the allele ranged from 0.179 in the Gaddi-Brahmin of Bharmour in Chamba district (Singh et al., 1982) to 0.262 in the Brahmin of Kangra district (Papiha et al., 1982). Among the Rajput groups, it varied from as low as 0.124 in the Gaddi-Rajput of Bharmour in Chamba district (Singh et al., 1982) to 0.325 in their counterpart inhabiting Chuwari in the same district (Papiha et al., 1996). The ESD allele frequencies recorded in the samples from Solan district therefore are well within the respective ranges reported for the Brahmin and Rajput subpopulations of the state. Furthermore, the present Brahmin sample did not reveal any statistically significant differences with any other Brahmin group of Himachal Pradesh. However, the Rajput sample did show heterogeneity with the Gaddi-Rajput of Bharmour in Chamba district ($\chi^2 = 9.5308$, d.f. 2, $0.01 > p > 0.001$) as well as with the Gaddi-Rajput of Kangra district ($\chi^2 = 10.878$, d.f. 2, $0.01 > p > 0.001$).

In the phosphoglucosyltransferase locus 1 (PGM1) polymorphism, besides the common phenotypes, an example of a rare variant PGM1 1,3 in the Brahmin and of another variant PGM1 1,7 in the Rajput were found in the present material from Solan district (Table 1). The *PGM1*2* allele showed a frequency of 0.3333 in the Brahmin and 0.2781 in the Rajput (Table 2). Among the Brahmins of Himachal Pradesh, the frequency of this allele has been reported from 0.229 in the Gaddi-Brahmin of Bharmour in Chamba district (Singh et al., 1982) to 0.3198 in the Brahmin of Shimla district (Sarin and Chahal, 2001). In the Rajputs, it varied from 0.207 in the Gaddi-Rajput of Bharmour in Chamba district (Chahal et al., 1982)

Table 2: Allele frequency distribution of erythrocyte (red cell) enzymes in the Brahmin and Rajput caste populations of Solan district (Himachal Pradesh)

System	Allele	Brahmin	Rajput
ADA	<i>ADA*1</i>	0.9648	0.9125
	<i>ADA*2</i>	0.0352	0.0875
AK1	<i>AK1*1</i>	0.9261	0.9156
	<i>AK1*2</i>	0.0739	0.0844
ESD	<i>ESD*1</i>	0.7676	0.7688
	<i>ESD*2</i>	0.2324	0.2313
PGM1	<i>PGM1*1</i>	0.6631	0.7188
	<i>PGM1*2</i>	0.3333	0.2781
	<i>PGM1*3</i>	0.0035	-
	<i>PGM1*7</i>	-	0.0031
ACP1	<i>ACP1*A</i>	0.2589	0.3344
	<i>ACP1*B</i>	0.7270	0.6500
	<i>ACP1*C</i>	0.0142	0.0156
GLO1	<i>GLO1*1</i>	0.2254	0.1656
	<i>GLO1*2</i>	0.7746	0.8344
GPI	<i>GPI*1</i>	0.9824	0.9906
	<i>GPI*3</i>	0.0176	0.0031
	<i>GPI*5</i>	-	0.0063

to 0.290 in their counterpart inhabiting Kangra district (Papiha et al., 1982). The frequency of the *PGM1*2* allele observed in the present Brahmin sample from Solan district was therefore the highest so far found in any regional group of this caste of Himachal Pradesh; as for the Rajput, it fitted quite well in the range observed in various samples of this caste studied from the state. Like in the AK1 system, in the PGM1 system also, statistical comparisons of the Brahmin as well as Rajput subpopulations of Solan district did not reveal any significant differences with their respective counterparts inhabiting different other districts of the state. Thus, there is evidence from at least these two enzyme polymorphisms for genetic homogeneity among various regional groups of the Brahmin of Himachal Pradesh on one hand and the Rajput on the other.

All the three common phenotypes (A, A,B, B) of the acid phosphatase locus 1 (ACP1) system alongwith two less common ones (A,C, B,C) were found in the either caste sample tested from Solan district (Table 1). As for allele frequencies, the *ACP1*A* showed a value of 0.2589 in the Brahmin and 0.3344 in the Rajput (Table 2). The range of the allele reported earlier among the Brahmins of Himachal Pradesh was from 0.225 (Singh et al., 1982) to 0.308 (Chahal et al., 1982) incidentally recorded in two different samples of the Gaddi-

Brahmin of Bharmour in Chamba district. It was from 0.215 in the Gaddi-Rajput of Palampur in Kangra district (Singh et al., 1982) to 0.342 in the Rajput of Churah in Chamba district (Papiha et al., 1996). Into these ranges, the *ACP1**A values of the two respective caste populations studied here from Solan district fit well. Statistical comparisons of the present Brahmin sample from Solan district with other Brahmin groups of Himachal Pradesh did not reveal any significant differences. However, the Rajput of this district showed such differences with those of Shimla district ($\chi^2 = 7.57$, d.f. 2, $0.05 > p > 0.02$) and the Gaddi-Rajput of Palampur in Kangra district ($\chi^2 = 7.6944$, d.f. 2, $0.05 > p > 0.02$).

Unlike other erythrocyte enzyme systems, polymorphism of glyoxalase locus 1 (*GLO1*) has been only occasionally inquired into the people of Himachal Pradesh. In fact, prior to a recent report (Sarin and Chahal, 2001), comparative data on the distribution of this red cell enzyme in the state were available only from Chamba district. All the three common phenotypes of the system were present in both the caste groups studied here from Solan district (Table 1) and the *GLO1**1 frequency recorded among them was 0.2254 in the Brahmin and 0.1656 in the Rajput (Table 2). In the two Brahmin samples reported earlier from Himachal Pradesh, the allele showed a frequency of 0.167 in Chamba district (Chahal et al., 1991) and 0.2027 in Shimla district (Sarin and Chahal, 2001). Among the Rajput samples, it ranged from 0.232 in Chamba town (Chahal et al., 1991) to 0.265 in Churah (Papiha et al., 1996), both in Chamba district. Evidently, the Brahmin and Rajput groups of Solan district have shown, respectively, a higher and a much lower value of the *GLO1**1 allele in respective subpopulations of these two predominant castes of the state. Statistical comparisons demonstrated highly significant differences between the Rajput of Solan district and the Gaddi-Rajput of Chuwari ($\chi^2 = 9.2532$, d.f. 2, $0.01 > p > 0.001$), the Rajput of Chuwari ($\chi^2 = 10.1460$, d.f. 2, $0.01 > p > 0.001$) and the Rajput of Churah ($\chi^2 = 9.2541$, d.f. 2, $0.01 > p > 0.001$). Interestingly, no such differences were found between the present Brahmin sample and different other regional groups of the caste reported from elsewhere in the state.

Essentially, the red cell enzyme glucose-

phosphate isomerase (GPI) does not show much variation in any population of the world, including India. Only rare variants are encountered, which sometimes reach polymorphic proportions, especially in some Asian populations (Papiha and Chahal, 1984). In the present material from Solan district of Himachal Pradesh, 5 examples of the variant GPI 1,3 were detected in the Brahmin and one in the Rajput sample. Another rare variant of the enzyme found in this study was GPI 1,5, met in two Rajput subjects. Earlier observations on this enzyme system had revealed the existence of GPI 1,3 variant in most of the regional groups of the Brahmin and Rajput studied from Himachal Pradesh, including those inhabiting Shimla district (Sarin and Chahal, 2001). Its finding in Solan district also therefore once again corroborates widespread distribution of GPI 1,3 in the Brahmin as well as Rajput populations of the state. Papiha and Chahal (1984) reported 3 cases of GPI 1,5, another variant of GPI in emigrant Nepali population inhabiting Kangra district. Barring this, there was no other report on the occurrence of this rare GPI type from Himachal Pradesh. Thus, the present study provides the first ever evidence of the existence of GPI 1,5 variant in indigenous caste populations of the state.

CONCLUSION

Thus the present molecular genetic study among the Brahmin and Rajput of Solan district of Himachal Pradesh has, first, helped characterize them genetically, using allele frequency data from various erythrocyte enzyme systems. Secondly, when compared with their respective counterparts inhabiting different other districts of the state, the present caste groups did not reveal any significant differences with most of them. In fact, in some systems there was complete homogeneity. This suggests similarity in genetic constitution of various regional groups (subpopulations) of the Brahmin population on one hand and the Rajput population on the other inhabiting north-west Indian state of Himachal Pradesh.

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KEY WORDS Erythrocyte Enzyme Polymorphisms. Caste Populations. Himachal Pradesh.

ABSTRACT Data are presented on phenotype and allele frequency distributions of seven polymorphic red cell enzymes in two predominant caste populations of Himachal Pradesh viz. the Brahmin and Rajput inhabiting southern district of Solan. The results of this molecular biology investigation demonstrate that apparently there was similarity in genetic constitution of the present two caste groups. Furthermore, either group was found to be homogeneous with its counterparts reported earlier from different other regions (districts) of this north-west Indian state.

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