Blood Groups in the Nepalese Native Chicken

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Abstract The frequencies of blood group alleles in Nepalese native chickens were investigated. A total of 243 blood samples were collected from the native chickens of four different geographical locations in Nepal. The gene frequencies at four blood group (*A*, *B*, *D* and *E*) loci were examined. At the *A* locus, the frequency of genes having the *F* factor was considerably higher than those of other factors, while the *C'* factor was not found in Nepalese native chickens. The frequency of the *A^F* allele showed an altitudinal difference: i.e. the frequency was higher in high altitude areas than in low altitude areas. At the *B* locus, the frequency of *B^L* was higher in the lowland than other areas. The *B^P* allele was found with the lowest frequency only in the Pokhara area. The *B^A*, *B^E* and *B^M* alleles were not found in Pokhara and lowland areas. The coefficient of gene differentiation (G_{ST}) and the average heterozygosity ($\bar{H}$) per individual were estimated to evaluate genetic differentiation in Nepalese native chickens. The estimate of G_{ST} was a comparatively low value, 0.1285.

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About nine million chickens are raised for meat and egg production in Nepal¹⁾. Although most of the chickens in Nepal are native chickens, the number of pure native chickens seems to be decreasing gradually. The Nepalese government is trying to improve productivity by introducing modern breeds such as the New Hampshire, Rhode Island Red, White Leghorn, White Cornish, and Barred Plymouth Rock. Therefore, it is an urgent problem to estimate the genetic background of Nepalese native

chickens as a genetic resource.

The study of the frequencies of four blood loci of native chickens is part of a field survey done on Nepalese domestic animals.

Materials and Methods

Areas surveyed

Blood samples were collected from the native chickens in four different geographic locations. The number and locality of the collected blood samples are shown in Fig. 1. The highland is

Fig. 1. Surveyed areas and number of chickens examined
A-a : High land (Solu), A-b : High land (Jomson road), B : Kathmandu, C : Pokhara, D : Low land.

formed by a region of hills lying at an altitude between 1500 m to 3000 m, Kathmandu is a basin lying at an altitude of about 1500 m, while Pokhara is located at an altitude of 500 m. The lowland is formed by the southern flat land lying at an altitude of less than 500 m.

Blood collection and blood typing

Heparinized blood samples were collected from a wing vein and red blood cells were washed with a physiological saline by centrifugation (1500 rpm, for 5 minutes) three times. Four blood group systems of A, B, D, and E were tested by hemagglutination. The number of reagents used for blood typing were four for A, ten for B, and two each for D and E systems. Blood typing was carried out at the Laboratory of Teaching Hospital, Tribhuvan University, Kathmandu.

The nomenclature of blood group alleles used in this study was given by MATSUMOTO and OKADA⁸⁾ and is not necessarily the same as those of BRILES^{1,2)}.

Estimation of gene frequencies and genetic variability

The frequencies of the blood group alleles were estimated by the method described by ITO and KANEMAKI⁵⁾.

Genetic variability within population was determined by measuring the average heterozygosity per individual, $\bar{H}$. The heterozygosity was calculated by the following formula¹⁰⁾:

$$\bar{H} = 2n(1 - \sum x_i^2)/(2n - 1)$$

where x_i is the frequency of the i th allele at a locus, n is the sample number and the bar is the overall average of the loci, including monomorphic loci.

The relative magnitude of genetic differentiation among local populations of the Nepalese native chickens was estimated using the coefficient of gene differentiation, G_{ST} ⁹⁾. The coefficient was calculated by the following formula:

$$G_{ST} = D_{ST}/H_T,$$

where H_T is the average heterozygosity of the native chickens, calculated from the average gene frequencies of local populations, and D_{ST} is the difference between the H_T and H_S , the mean of average heterozygosity of local populations.

Results and Discussions

Table 1 shows the gene frequencies of the blood group A locus in the Nepalese native chickens. The frequency of genes having the F factor was considerably higher than those of

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Table 1. Gene frequencies at the blood group A locus in the Nepalese native chickens

Locality	No. of birds	Gene frequency						
		A^F	A^R	A^Z	A^{FR}	A^{FZ}	A^{RZ}	a
High land	122	.4846	.0840	.0288	.0164	.0178	0	.3683
Solu area	67	.4994	.0798	0	.0250	.0230	0	.3728
Jomson road area	55	.4425	.0590	.0603	.0355	.0170	0	.3857
Kathmandu	29	.2348	.1698	.0526	.0299	0	0	.5100
Pokhara	32	.3293	.0668	0	0	0	0	.6036
Low land	60	.1183	.2270	.0262	.1315	0	.0346	.4624
Total	243	.3216	.1123	.0255	.0534	.0161	.0091	.4620

Table 2. Gene frequencies at the blood group B locus in the Nepalese native chickens

Locality	No. of birds	Gene frequency						
		B^{AX}	B^{BX1}	B^C	B^D	B^E	B^G	B^{GX}
High land	122	.0243	.0162	.0160	0	.0114	.0524	.0288
Solu area	67	.0411	.0350	0	0	0	0	.0192
Jomson road area	55	0	0	.0186	0	.0049	.1202	.0218
Kathmandu	29	.0210	.0175	0	0	0	0	.0578
Pokhara	32	0	.0206	.1364	.0230	0	0	.0414
Low land	60	0	0	0	0	0	.0701	.0249
Total	243	.0049	.0149	.0367	.0023	.0051	.0345	.0480

¹X indicates that some similar phenogroups were pooled

Table 2. Continued

Locality	No. of birds	Gene frequency						
		B^L	B^{LX}	B^M	B^{MX}	B^{LMX}	b	Others
High land	122	.2408	.0318	.0486	.0528	.1165	.3632	.0240
Solu area	67	.1729	.0449	.0389	.1001	.1375	.3992	.0112
Jomson road area	55	.2390	.0388	.0876	0	.1328	.3027	.0336
Kathmandu	29	.0937	.0558	.0265	.0175	.1477	.5350	.0275
Pokhara	32	.0258	0	0	.0989	.1071	.4430	.1029
Low land	60	.4792	.3297	0	.0448	.0183	0	.0593
Total	243	.2105	.0490	.0412	.0974	.1009	.3270	.0274

other factors, while the C' factor was not found. The frequency of A^F allele was lower than that of Bangladesh, but higher than those of Sri Lanka and Indonesian native chickens¹¹⁾. The frequency of a allele was similar to that of Sri Lanka¹¹⁾, but higher than that of Bangladesh native chickens. A difference in frequency was found in that the frequency of

A^F allele was higher in the high altitude areas. A similar finding was reported in the frequency of $Hb-I^A$ allele of Bangladesh native chicken populations¹¹⁾.

The gene frequencies at the blood group B locus are shown in Table 2. The frequencies of blood group alleles at the B locus showed considerable variation among local popula-

Table 3. Gene frequencies at the blood group *D* and *E* loci in the Nepalese native chickens

Locality	No. of birds	Gene frequency							
		<i>D</i> locus				<i>E</i> locus			
		<i>D^Q</i>	<i>D^S</i>	<i>D^{Qs}</i>	<i>d</i>	<i>E^W</i>	<i>E^Y</i>	<i>E^{WY}</i>	<i>e</i>
High land	122	.4408	.1697	.0042	.3853	.4719	.0085	.0330	.4866
Solu area	67	.4900	.1557	.0069	.3474	.4731	.0149	.0232	.4889
Jomson road area	55	.3918	.1743	.0057	.4282	.4768	0	.0370	.4862
Kathmandu	29	.4172	.1504	0	.4321	.1490	0	0	.8510
Pokhara	32	.1302	.0594	0	.7830	.1598	.0870	0	.7527
Low land	60	.5533	.1275	.0627	.2565	.6891	.0708	0	.2401
Total	243	.4058	.1346	.0241	.4355	.4179	.0366	.0095	.5359

Table 4. Genetic variations of the local populations in Nepal

Locality	No. of birds	$\bar{H} \pm S.E$
High land	22	0.6461 $\pm$ 0.1026
Solu area	67	0.6481 $\pm$ 0.1220
Jomson road area	55	0.6300 $\pm$ 0.1320
Kathmandu	29	0.4801 $\pm$ 0.1935
Pokhara	32	0.5175 $\pm$ 0.1735
Low land	60	0.6104 $\pm$ 0.1027
Total	243	0.6623 $\pm$ 0.1178

tions. A total of 43 alleles were found at the *B* locus in the Nepalese native chicken. The number of alleles within the local populations varied from 8 to 18. The highest frequency of *b* allele was found in the Nepalese native chicken, higher than those in native chickens of other Asian countries¹¹. The *B^L* allele was the next highest and this was higher in the lowland than those in Kathmandu, Pokhara and the highland populations. The *B^D* allele was found with a low frequency only in the Pokhara population. The *B^A*, *B^E* and *B^M* alleles were not found in Pokhara and the lowland populations. The allele having a *G* factor was found to have a similar frequency to Sri Lanka and Indonesian native chickens^{11,12}, but this frequency was lower than those found in Japanese native chicken populations¹³.

Concerning the *D* and *E* loci, their gene frequencies are shown in Table 3. The *D^Q*

allele was found with a considerably higher frequency in the Nepalese native chickens, which was similar to those in the Sri Lanka and Indonesian native chicken populations^{11,12}. The frequency of *D^Q* allele in Pokhara was lower than those found in other populations in Nepal. At the *E* locus, the frequency of *E^W* allele was similar to those of native chickens in Japan and other Asian countries^{11,13}. Its frequency in Kathmandu and Pokhara was lower than those found in other populations in Nepal.

To evaluate genetic differentiation and genetic variability within local chicken populations, and the average heterozygosity per individual ($\bar{H}$) was estimated as shown in Table 4. The $\bar{H}$ values of Nepalese native chickens were estimated as 0.48 to 0.65. These estimates were considerably higher than those of Japanese native chickens¹⁴. The $\bar{H}$ in the present study was estimated only from blood group data, while the estimate for Japanese native chickens included data from blood groups and protein polymorphisms. In general, protein polymorphisms include many monomorphic loci, so, their $\bar{H}$ values estimated from the data of protein polymorphisms will be small^{3,4,7}. The coefficient of gene differentiation in the Nepalese native chickens was estimated as 0.1285. When the G_{st} value was compared with those of other native chickens and improved breeds, it was higher than those in

Japanese and Bangladesh native chickens¹¹⁾. This was lower than those from improved breeds, such as White Leghorn and Rhode Island Red¹⁴⁾. These results suggest that the degree of genetic differentiation among the Nepalese native chicken populations is not pronounced.

References

- 1) BRILES, W.E., Current status of blood groups in domestic birds. *Z. Tierz. Züchtungsbiol.*, **79**: 371-391. 1964.
- 2) BRILES, W.E. and R.W. BRILES, Identification of haplotypes of the chicken major histocompatibility complex (*B*). *Immunogenetics*, **15**: 449-459. 1982.
- 3) HASHIGUCHI, T., T. NISHIDA, Y. HAYASHI and S.S. MANSJOER, Blood protein variations of the native and the jungle fowls in Indonesia. *Rep. Soc. Res. Native Livestock*, **10**: 190-200. 1983.
- 4) HASHIGUCHI, T., S. OKAMOTO, T. NISHIDA, Y. HAYASHI, H. GOTO and H.W. CYRIL, Blood protein variations of the Ceylon jungle fowl and native fowl in Sri Lanka. *Rep. Soc. Res. Native Livestock*, **11**: 193-207. 1986.
- 5) ITO, S. and M. KANEMAKI, A computer-aided procedure for finding probable phenogroups from the phenotype distribution in the bovine B blood group system. *Jpn. J. Zootech. Sci.*, **58**: 591-603. 1987.
- 6) JOSHI, R.M. and M.K. KHATIWADA, *Agricultural Handbook: Nepal*, 154-157. Agri. Publication Series. Kathmandu. 1986.
- 7) MAEDA, Y., I. OKADA, T. HASHIGUCHI and M.A. HASNATH, Blood protein polymorphisms of native fowl and red jungle fowl in Bangladesh. *Rep. Soc. Res. Native Livestock*, **12**: 233-250. 1988.
- 8) MATSUMOTO, K. and I. OKADA, The blood group systems in the chicken. *Jpn. J. Genet.*, **36**: 257-267. 1961.
- 9) NEI, M., Analysis of gene diversity in subdivided population. *Proc. Nat. Acad. Sci.*, **70**: 3321-3323. 1973.
- 10) NEI, M., Estimation of average heterozygosity and genetic distance from a small number of individuals. *Genetics*, **89**: 583-590. 1978.
- 11) OKADA, I., Y. MAEDA and M.M. HASNATH, Blood groups of indigenous chickens in Bangladesh. *Rep. Soc. Res. Native Livestock*, **12**: 227-232. 1988.
- 12) OKADA, I., T. NISHIDA, T. HASHIGUCHI and S. ITO, Blood group variations in native fowls in Indonesia. *Rep. Soc. Res. Native Livestock*, **10**: 201-208. 1983.
- 13) OKADA, I., Y. YAMAMOTO, T. HASHIGUCHI and S. ITO, Phylogenetic studies on the Japanese native breeds of chickens. *Jpn. Poult. Sci.*, **21**: 318-329. 1984.
- 14) OKADA, I., Y. YAMAMOTO, A. SHINJO, S. KIMURA and H. HIRAOKA, Studies of genetic differentiation within breeds of Japanese indigenous chickens, *Jpn. Poult. Sci.*, **26**: 207-215. 1989.

ネパール在来鶏の血液型

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ネパール在来鶏の血液型を観察するために、ネパール北東部および中北部の高地地域、カトマンズ周辺地域、ポカラ周辺地域、平野部の低地地域の4地域で合計243羽の在来鶏より採血を行なった。血液型の判定には4つのシステムを用い、Aシステムは4種、Bシステムは11種、DとEシステムは各々2種の合計19種の抗血清を用いて凝集反応を行なった。血液型の遺伝子頻度の分析を行ない、調査地域間および他のアジア地域の在来鶏と比較検討した。得られた主な結果は以下の通りである。

1) A座位では、F因子を持つ遺伝子の頻度が他の因子を持つものより高いことが特徴的であり、C'因子はネパール在来鶏には認められなかった。A^F遺伝子の頻度には、北部の高地から南部の低地への地理的な傾斜が見られた。

2) B座位では、b遺伝子の頻度が最も高く、他のアジア諸国の在来鶏と比べても高い頻度であった。一方、B^D遺伝子の頻度は最も低く、ポカラ周辺の在来鶏からのみ見い出された。B^G遺伝子の頻度はスリランカ、インドネシアおよびバングラデシュの在来鶏の頻度と似ていたが日本在来鶏に比べて低かった。

3) DおよびE座位については、これ迄調査されたアジアの在来鶏と比較的似た傾向を示した。

4) ネパール在来鶏の地域集団間の遺伝的分化の程度を表す G_{ST} は0.125と評価された。

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