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# Relationship of Haemoglobin Variants with Some Metabolic Constituents in the Indian Sheep

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The Hb-A type Indian sheep were found to have high glucose concentration, which is consistent with the physiological needs of high glucose concentration in the blood of animals living in high altitudes. The variations in the concentration of other metabolites in the different haemoglobin types were statistically insignificant.

**Key Words: Relationship, Haemoglobin variants, Metabolites, Blood, Sheep.**

## INTRODUCTION

The specificity of proteins and their structure, the qualitative and quantitative occurrence of enzymes and their actions, the patterns of metabolic behaviour, all are controlled by genes is a well established fact. The genetic variations in nature are brought about by mutation of genes. As the process of evolution in animal kingdom proceeds, a number of genes have mutated, many have been eliminated by selection and many are occurring in what is termed as a balanced polymorphism.

Extensive work[1–8] has been done to examine the relationship among the various naturally occurring polymorphic types and adaptability not only in human beings but also in animals. Hb-A was found to be advantageous to sheep living at the high mountains[9]. Evans and Terner[10] found higher fertility in sheep associated with B type of Hb. Somewhat similar results were reported by Arora *et al.*[11, 12]. Sheep with high potassium concentration in RBC were reported to have a predominating occurrence at higher altitudes[13, 14]. Sheep with low RBC potassium concentration were found to have higher body and fleece weight in Marwari breeds[15]. Taneja[16] found that the sheep containing low potassium had 16 to 23 per cent fewer medullated fibres than the sheep containing high potassium concentration in RBC.

All carbohydrates which are the main source of energy to the animal body are perhaps metabolised after their conversion to glucose. The blood glucose levels which are extremely variable may reflect the availability of this metabolite to the body tissue. Similarly calcium, phosphorus, iron etc. in blood reflect the nutritional status and are indirect indices of their supply and utilization by the animal body, *i.e.*, are the indicators of their being metabolised in the various systems. Therefore, a number of metabolites like blood-glucose, serum total protein, nonprotein nitrogen, calcium, inorganic phosphorus, iron, chlorides, plasma bicarbonates, etc. have been attempted in the present study to establish the relationship of the haemoglobin variants with these metabolites.

## EXPERIMENTAL

### The animals and collection of the blood samples

The Bikaneri lambs and the Bikaneri adult sheep were maintained at the Department of Physiology, U.P. College of Veterinary Science and Animal Husbandry, Mathura and the blood samples were collected as reported earlier[17]. Serum was prepared using a buffer of veronal acetate[18].

### Haemoglobin typing of the animals

Hb-A, Hb-B and Hb-AB types of haemoglobin were observed by the electrophoresis method as reported earlier[17].

### Estimation of the metabolites in blood/serum

Blood sugar was estimated by the Hagedorn and Jensen method , non-protein was estimated by Koch and McMeekin method and serum calcium was estimated by the modified Kromer and Tisdell method. Serum inorganic phosphorus, serum chloride and plasma bicarbonate contents were determined by the Fiske and Subba Rao, Whitehorn and Vanslyke's methods respectively. All these methods and estimation of proteins were described by Hawk *et al.*[19] Serum iron was estimated by the method of Marrack *et al.*[20]

## RESULTS AND DISCUSSION

The Hb polymorphism and the gene frequencies were reinvestigated and were in perfect agreement with the results reported earlier.[17] The concentration of blood glucose, serum total protein, non-protein nitrogen, serum calcium, inorganic phosphorus, serum chloride, plasma bicarbonate and serum iron have been given in Tables 1 to 9.

TABLE-1
AVERAGE CONCENTRATION OF CERTAIN CONSTITUENTS IN BLOOD/SERUM/ PLASMA OF SHEEP OF DIFFERENT Hb POLYMORPHIC TYPES

| Hb type | mg/100 mL | | | | | | | μg/100 mL |
|---|---|---|---|---|---|---|---|---|
| | lucose blood | Total protein serum | NPN serum | Ca serum | P (inorganic) serum | Cl serum | Bicarbonate plasma | Fe serum |
| A | 72.92 ± 5.72 | 7.40 ± 0.91 | 35.60 ± 3.08 | 10.60 ± 0.50 | 5.60 ± 0.28 | 557.67 ± 72.30 | 19.67 ± 0.76 | 33.88 ± 0.95 |
| B | 65.98 ± 5.78 | 5.43 ± 0.61 | 41.24 ± 2.76 | 10.22 ± 0.64 | 5.97 ± 0.30 | 598.80 ± 15.07 | 19.44 ± 0.66 | 34.84 ± 1.50 |
| AB | 69.24 ± 4.51 | 7.23 ± 0.65 | 43.65 ± 3.99 | 11.15 ± 0.44 | 5.69 ± 0.30 | 571.75 ± 11.79 | 17.62 ± 0.76 | 40.05 ± 2.25 |

TABLE-2
ANALYSIS OF VARIANCE OF BLOOD GLUCOSE CONCENTRATION IN DIFFERENT HAEMOGLOBIN TYPES

| Source of variation | d.f. | SS | MSS | F value | Remarks |
|---|---|---|---|---|---|
| Between types | 2 | 184.1919 | 92.0959 | | |
| | | | | 0.2924 | NS |
| Error | 29 | 9133.9269 | 314.9630 | | |
| Total | 31 | 9318.1188 | | | |

TABLE-3
ANALYSIS OF VARIANCE OF TOTAL SERUM PROTEIN CONCENTRATION IN DIFFERENT HAEMOGLOBIN TYPES

| Source of variation | d.f. | SS | MSS | F value | Remarks |
|---|---|---|---|---|---|
| Between types | 2 | 23.6083 | 11.8041 | | |
| | | | | 2.1223 | NS |
| Error | 29 | 161.2994 | 5.5620 | | |
| Total | 31 | 184.9077 | | | |

TABLE-4
VARIANCE OF SERUM N.P.N. CONCENTRATION IN DIFFERENT HAEMOGLOBIN TYPES

| Source of Variation | d.f. | SS | MSS | F value | Remarks |
|---|---|---|---|---|---|
| Between types | 2 | 283.4220 | 141.7110 | | |
| | | | | 0.8549 | NS |
| Error | 29 | 4807.7642 | 165.7850 | | |
| Total | 31 | 5091.1862 | | | |

TABLE-5
ANALYSIS OF VARIANCE OF SERUM CALCIUM CONCENTRATION IN DIFFERENT HAEMOGLOBIN TYPES

| Source of variation | d.f. | SS | MSS | F value | Remarks |
|---|---|---|---|---|---|
| Between types | 2 | 5.50 | 2.7500 | | |
| | | | | 0.8661 | NS |
| Error | 29 | 92.08 | 3.1752 | | |
| Total | 31 | 97.58 | | | |

TABLE-6
ANALYSIS OF VARIANCE OF SERUM PHOSPHORUS CONCENTRATION IN DIFFERENT HAEMOGLOBIN TYPES

| Source of Variation | d.f. | SS | MSS | F value | Remarks |
|---|---|---|---|---|---|
| Between types | 2 | 1.25 | 0.6250 | | |
| | | | | 0.5572 | NS |
| Error | 29 | 32.53 | 1.1217 | | |
| Total | 31 | 33.78 | | | |

TABLE-7
ANALYSIS OF VARIANCE OF SERUM CHLORIDE CONCENTRATION IN DIFFERENT HAEMOGLOBIN TYPES

| Source of Variation | d.f. | SS | MSS | F value | Remarks |
|---|---|---|---|---|---|
| Between types | 2 | 7426 | 3713.00 | | |
| | | | | 1.5496 | NS |
| Error | 29 | 69488 | 2396.14 | | |
| Total | 31 | 76914 | | | |

TABLE-8
ANALYSIS OF VARIANCE OF PLASMA BICARBONATE CONCENTRATION IN DIFFERENT HAEMOGLOBIN TYPES

| Source of Variation | d.f. | SS | MSS | F value | Remarks |
|---|---|---|---|---|---|
| Between types | 2 | 26.65 | 13.3250 | | |
| | | | | 1.9562 | NS |
| Error | 29 | 197.54 | 6.8117 | | |
| Total | 31 | 224.19 | | | |

TABLE-9
ANALYSIS OF VARIANCE OF SERUM IRON CONCENTRATION IN DIFFERENT HAEMOGLOBIN TYPES

| Source of Variation | d.f. | SS | MSS | F value | Remarks |
|---|---|---|---|---|---|
| Between types | 2 | 251.52 | 125.7600 | | |
| | | | | 2.5148 | NS |
| Error | 29 | 1450.23 | 50.0079 | | |
| Total | 31 | 1701.75 | | | |

NS = Non-significant.

Wide variations in the per cent distributions of the different haemoglobin types were also reported by Evans *et al.*[9] Studies on Hb polymorphism by Evans and Blunt[21] indicated an adaptive significance to haemoglobin types. It was claimed by these workers that Hb-A was more suited for the mountainous region. If this is true it may be assumed that it would effect the general body metabolism of these animals. Glucose is an important metabolite and its concentration in blood is the result of a number of biochemical reactions and is maintained by an active and continuous exchange between liver and body cells. A number of hormones and enzymes are involved in this metabolic process.

The average concentration of blood glucose of different haemoglobin types in this study was Hb-A 72.92 ± 5.72; Hb-B 65.98 ± 5.78 and Hb-AB, 69.24 ± 4.51 mg per 100 mL of blood (Table-1). The Hb-A type of animals had the highest glucose concentration in the blood. The incidence of Hb-A type has earlier been reported to be high in the mountain sheep.[9]

This observation is consistent with the physiological needs of higher glucose concentration in the blood of animals inhabiting the high altitudes. However, the variations in glucose concentration when examined statistically were not found to be significant (Table-2).

The concentration of other metabolite studies, *viz.*, total protein, NPN, serum calcium, serum inorganic phosphorus, serum chloride, plasma bicarbonate and serum iron in sheep of different haemoglobin types have been given in Table-3. Though variations in values of certain metabolites have been observed in the different Hb types, yet the variations were not significant statistically.

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