Indian Journal of Animal Sciences 64(2): 153-156, February 1994

Pre- and post-embryonic haemoglobin variations in guineafowl

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Received: 5 July 1993

ABSTRACT

Guineafowl haemoglobin electrophoretic components revealed a typical avian pattern, consisting of a major and a minor component. Keets and growers up to 20 weeks of age also revealed another slow-moving minor band suggesting the presence of embryonic haemoglobin component Hb-H. Five embryonic haemoglobin components, viz. A, D, P, E and H, were identified. Embryonic to adult haemoglobin switchover was observed around day 9 of incubation. A variant phenotype was observed in 3% embryos.

Haemoglobin polymorphism is not widespread among domesticated avian species. Extensive survey of diversified *Galliform* populations revealed genetic polymorphism for minor haemoglobin component in Japanese quail and certain chicken populations (Washburn 1976, Cheng and Kimura 1990). No individual variations have been reported among adult guineafowl populations (Hilgert and Vojtiskova 1959, Singh and Singh 1988).

Existence of multiple embryonic haemoglobin forms specific for different developmental stages have been reported for chicken, ducks, turkey, goose and quails.

Species differences have been identified at the time of switch-over from embryonic to adult haemoglobin (Manwell *et al.* 1966, Denmark and Washburn 1969, Keane *et al.* 1974, Stratil and Valenta 1976). The information regarding embryonic switchover has genetic importance since it concerns the regulator gene functions.

MATERIALS AND METHODS

The present investigations were carried out in the guineafowl stocks being maintained at the CARI, Izatnagar. A total of 785 blood samples (15 keets, 329 growers, 375 adults and 66 embryos) were studied. Embryonic samples were obtained from the main blood vessels or directly from the heart. Haemolysate from thrice-washed erythrocytes (1:3) were subjected to starch-gel electrophoretic procedures as detailed by Singh and Singh (1988).

RESULTS AND DISCUSSION

Post-embryonic phenotypes during zone electrophoresis guineafowl haemoglobin revealed a typical avian haemoglobin electrophoretic pattern: a major component (M or Hb-I) comprising about 70-80% of total haemoglobin and a minor component (m or Hb-II) constituting the remainder. A third minor acidic component (Hb-III) was observed in all keets and growers only. These observations were consistent with the earlier described results for *Galliform* species in general and guineafowl in particular (Hilgert and Vojtiskova 1959, Singh and Singh 1988). Extensive survey of diversified chicken populations by different workers established

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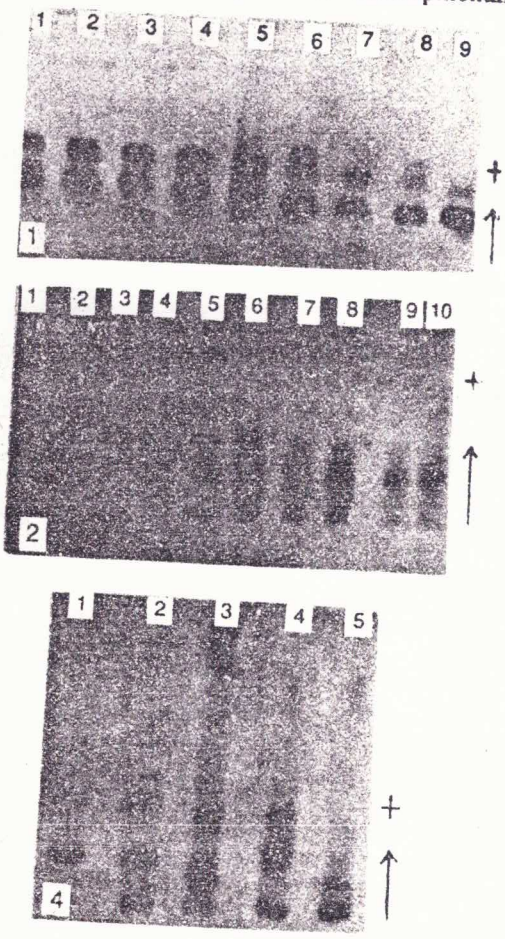
low incidence of very similar haemoglobin mutant forms in certain genetic groups. Except the mutant form reported among Japanese Bantam all other reports pertain to chicken stocks of fairly recent common ancestory (Washburn 1976, Grunder 1990). Relatively higher occurrence of haemoglobin mutant among Japanese quail stocks was also attributed to the common ancestry of all commercial quail stocks (Cheng and Kimura 1990).

Comparison of guineafowl haemoglobin vis-a-vis chicken and quail (at pH 7.8) revealed almost identical electrophoretic mobility for minor components of guineafowl and chicken although major components differed slightly. Quail haemoglobin components were comparatively slower than that of guineafowl and chicken (Fig. 1). Amino acid characterization of the two chicken components by Moss and Thompson (1969) showed that β' and β" chains were more closely related and shared same amino terminal sequences, viz. val-his-gly, but α' and α" had distinctly different terminal sequences, viz. val-len-ser and met-len-thr respectively. The comparative electrophoretic behaviour of guineafowl, chicken and guineafowl × chicken hybrid haemoglobins suggest possible similarities in their amino acid constitutions; alternatively, the amino acid substitution (s), if any, have not changed their isoelectric charge.

Embryonic phenotypes

Progression from embryonic to adult guineafowl haemoglobin forms strictly resembles chicken haemoglobin differentiation (Fig. 2). A schematic representation of the same is presented in Fig.3. The 3-day-old embryos reveal 2 cathodal components: a major band (P) migrating anodically and a weakly stained band (E). This electrophoretic pattern continued till day 8 of incubation but by day 9 development of anodically migrating major (A) and minor (D) components takes place. The 5 components observed among guineafowl embryos between days 9-11 are analogous to the A, D, P, E and H embryonic haemoglobins described for chicken, turkey, goose and ducks by Stratil and Valenta (1976).

Species-specific differences were also identified with respect to haemoglobin switchover. In case of guineafowl, the adult haemoglobin molecules begin to appear by the end of day 8 or the beginning of day 9. While in chicken switchover commences around day 5 or 6 (Manwell *et al.* 1966, Stratil and Valenta 1976). This delay is commensurate with the relatively slower developmental



Figs 1, 2, 4. 1.Haemoglobin electrophoretic pattern of some poultry species: 1-2: Guinea fowl; 3-4: Hybrid; 5: Chicken; 6-9: Quail. 2 Embryonic haemoglobin variant of guinea fowl: 1: Adult; 2: Keet; 3: At hatch; 4: 16th day; 5: 12th day; 6: 11th day; 7: 10th day; 8: 9th day; 9: 8th day 10: 5th day. 4 Embryonic haemoglobin variant of guinea fowl: 1: Adult; 2: 17th day; 3: 17th day mutant; 4: 8th day 5: 8th day mutant.

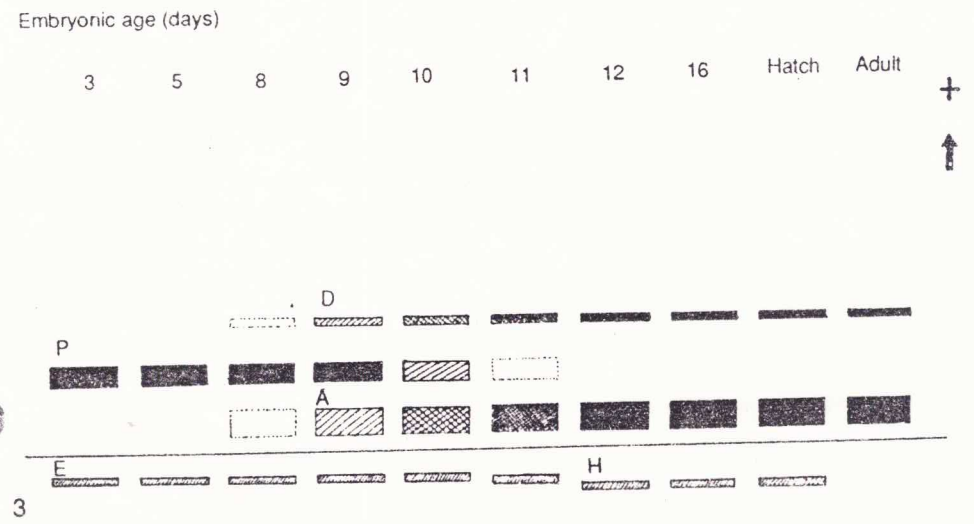


Fig. 3. Ontogeneic changes in guineafowl haemoglobin : A schematic representation.

process of guineafowl. The ontogency of adult haemoglobin is a phase-specific event; accordingly the timings of functional initiation of adult haemoglobin genes in both guineafowl and chicken also occur at the same stage of development.

Screening of embryonic haemoglobins also revealed the existence of 2 rare variations: (1) an intensely staining E band was present but Hb-P band was absent in an 8- day-old embryo (Fig. 4). (ii) An extra band moving ahead of the minor Hb-D band was identified in a 17-day-old embryo; A, D & H bands were diffused. These embryonic haemoglobin types are perhaps gene determined as reported for chicken by Keane *et al.* (1974). They observed that alleles responsible for abnormal structure were also associated with reduction of haemoglobin contents. Rare adult chicken and quail haemoglobin variants are also known to affect individual fitness in some form or other through impaired functions (Washburn 1976, Washburn and Yen 1976). A degree of association between mutant haemoglobin type and resistance to diseases has also been reported (Washburn and Edison 1971).

ACKNOWLEDGEMENT

Help rendered by the Indian Veterinary Research Institute in the form of Senior Research Fellowship to the first author is acknowledged.

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