Biochemical Polymorphism and its relation with some traits of importance in poultry

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The term 'protein' is derived from the Greek word 'Proteios' meaning primary and is therefore well chosen, since proteins the first recognizable and distinctive expression of genetic information. The structure of proteins enable them to act as the catalysts which control the rates of all biological reactions, to serve as the carriers essential substances within the organisms, to serve as regulators, of physiological relationship and to serve as building block units for substances, cellular and organic structures. The occurrence of two or more discontinuous forms of protein in a species in such a proportion that rarest of them cannot be maintained merely by recurrent mutation is called protein polymorphism. The knowledge about these biological variations or polymorphism systems has very wide ramifications and applications in biological sciences.

It is experimentally proved that all traits of production, reproduction and genetic diseases are controlled by the biochemical activities in the body of the individuals and these are accomplished by the several types of proteins such as serum protein, enzyme, hormone etc.. These different proteins show their effects in different ways viz. anabolic, catabolic, activating the substrate etc. which controls the growth, production and reproduction of the individuals.

Genetic Control on Biochemical Polymorphism: It is assumed that a single or more allelic pair of genes controls all types of biochemical polymorphism. It is also proved that several types of protein variations are due to the different number of amino acids present in the protein molecules and exert their effects in different manner.

A triplet code of nucleotide of DNA and RNA is responsible for coding of a particular amino acid to participate in the formation of a protein. In this way the different triplet codes present in a particular DNA or RNA sends different codes of words to different amino acids to come in a particular arrangement to form a particular protein which in permanently or temporarily required for a particular function of the body.

If the allelic pair of genes having the same nucleotide sequences in both the genes, they can send the same type of codes to the amino acids to come in contact to form the similar type of protein that is monomorphic protein. But if the allelic pair of genes having the different codones to different amino acids to come in contact in that particular sequence of nucleotide in the DNA or RNA to form the different protein molecules. By this genic controlled fashion, a different type of polymorphic protein is formed in the body and exerts their effects in different ways.

Biochemical Diversity : Biochemical diversity popularly called biochemical polymorphism is the occurrence of the varieties attributed to biochemical difference, which are under genetic control. A population is said to exhibit genetic polymorphism when two or more distinct inherited varieties co-existed in the same individuals. A genetic character is now to be polymorphic when the rarest phenotype has a frequency greater than one percent. Biochemical polymorphism has a wide occurrence in nature. Gene controls biochemical polymorphism hitherto revealed has provoked much discussion with respect to its origin, maintenance and significance of Heterozygosity. It is believed that the balance between the adaptive values of different gene types under varying environments would be responsible for its maintenance. The example of sickle cell haemoglobin trait in Africa is the most conclusively worked out condition of balance polymorphism.

During the recent year large number of biochemical polymorphic genetic characters of farm animals have been studied. Some important characters like blood group system, haemoglobin, transferrin etc. have been studied in greater details. The other types like albumin, alkaline phosphatase,

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amylase, a- lactalbumin, ß-lactalbumin have also been reported to have polymorphism.

Researchers on non-immunological blood proteins and protein variants in poultry are of recent achievements, the variants so far being isolated, transferrin - 4,, haemoglobin - 3, prealbumin - 2, plasma albumin - 2, egg albumin - 4, tetralorium oxidase - 3, carbonic anhydrase - 3 and serum alkaline phosphatase - 2.

The protein polymorphism being under multiple allelic controls, more protein variants are expected to be evolved by the researchers.

Objectives to Study the Biochemical Polymorphism :

i. The isozymes or multiple molecular forms of protein provides natural build in the genetic markers which help in determine the changes of genetic variability with a population and which can be used as labels in the study of selection, helping detection to raise better individuals.

ii. Robers (1966) described the importance of biochemical polymorphism in the improvement of chicken. It was also noted by Rendel (1967) that some of polymorphic alleles may be correlated with economic traits due to linkage pleotropy or general heterozygosity. If so far these polymorphic character expressed during the early life of an individual so that the selection can be made at right time without actual recording of the production of the progeny and genetic gain per unit of time can be increased.

iii. Genological studies of enzyme polymorphism can help in establishing on the study of development of breed of poultry, their origin and relationships and the evolutionary trends through which the various populations must have passed during diversification and speciation.

iv. The marker so developed through biochemical studies can prove to be helpful in evaluating genetically disease free strain in poultry and in establishing individuality and to solve disputed percentage.

v. The biochemical marker genes have been extensively utilized for documenting genetic similarities or diversities different population comprising a species or strains or even closely related lines.

Non-immunological Protein Polymorphism in relation to Economic Traits in Poultry : Blood protein including their variants in poultry also is definitely related with the economic traits in poultry. From the available literature some of the proteins and their genetic variants having specific roles on the control of economic traits may be outlined as below. But the information cited is definitely far for the adequacy.

A. Haemoglobin (Hb) variants : Haemoglobin is the principle molecule for transport of carbon dioxide in blood. It is a conjugated protein and consists of the protein globins and prosthetic group haemoglobin. Each molecule consists of four polypeptides. According to Dimri (1978), three types of haemoglobin have been observed which are controlled by two autosomal alleles A1 and A2.

Mazumder et al. (1989) interestingly reported that the frequencies of the normal Hb gene in white leghorn : 0.96, in broiler:1.00, in local fowl:1.00, in guinea fowl:1.00, in quail:0.85, corresponding figures for the normal mutant alleles were 0.04, 0.00, 0.00, 0.00 and 0.15.

Washburn et al. (1971) showed the chicken of the homozygous mutant haemoglobin, genotypes were approximately 20% less susceptible to Marek's disease.

The haemoglobin polymorphism affects the growth rate and hatchability(Dimri,1978). Hatchability was reported to be highest in AA (62.20%) followed by AB (48.20%) and BB (31.50%).

B. Transferrin (Tf) variants : In birds transferrin is known to function as bacteriostatic agent in eggs by altering the Fe^{++}/Co^{++} ratio. The transferrin polymorphism in poultry (light Sussex stock) first reported by Ogden et al. (1962).

Three types of alleles viz. TfA, TfB and TfC were observed in chicken by Jain (1977). On the gel electrophoresis separation the homozygous types were found to exhibit two bands while the heterozygous types 3-4 bands distinctively.

Stratil (1968) interestingly observed the chickens with a type 'TfB' to have the advantageous egg production over the chicken with TfA. According to the Lush (1966) the effect of heterozygous transferrin (TfBC) appears to be significant including variability in the fertility, hatchability and egg production (at least 90 days' production). Chicken with TfA appears to have delayed sexual maturity while the chicken with the TfB has the earlier age of sexual maturity.

C. Serum alkaline phosphatase (SAP) variants : It is an important enzyme in the chicken which is princely found in bones, kidney, liver, plasma, intestinal mucous. It functions to help in absorption of protein, carbohydrate and fat. Tamak and Tanaba (1970) reported two alleles viz. F and S in respect of SAP locus.

Wilcox (1965) and Choudhury et al. (1971) reported positive correlation of egg production with the enzyme. For age at sexual maturity the birds have fast type matured about almost 13 days as earlier than the birds having slow type. The egg mass and SAP level nearly gave a perfect phenotype and genetic correlation. The bodyweight of the fast and slow types were significantly different al all ages.

D. Carbonic anhydrase variants : The transport of Co2, Hb utilization for controlling pH of body fluids and selection for the production of carbonate ions are facilitated by carbonic anhydrase. Six phenotypes viz. AA, BB, CC, AB, AC BC were identified controlled by three co-dominant alleles (CA-1A, CA-1B and CA-1C) located at an autosomal locus CA-1. No significant differences were detected between various biochemical types and economic traits. However the activity of CA has been positively correlated with egg shell thickness.

E. Plasma albumin variants : Plasma albumin polymorphism in several brown leghorn chicken was reported by McIndone (1962). Two variants were distinguished and assumed to be detected by co-dominant alleles at one autosomal locus. Each variant is accompanied by a minor, faster or fraction space which varies its mobility in step with the main fraction.

F. Pre-albumin (Pa) variants : Wise et al. (1964) discovered that pre-albumin reached its highest concentration around 16th day in the chick embryo, whereas albumin concentration increased gradually up to two months after hatching (Stratil, 1979).

Three phenotypes viz. PaAA, PaBB and PaAB were controlled by PaA and PaB . No significant differences could be detected between various biochemical types and growth rate (Ahlawat,1981).

G. Egg albumin variants : By starch gel electrophoresis seven proteins are defined. But genetically four forms are found in various populations, named oval albumin, conalbumin and protein- II and III. Each polymorphism is due to the segregation of two co-dominant alleles at a separate autosomal locus. Egg albumin polymorphism plays to influence hatchability and viability of embryo.

H. Tetrarolium oxidase (TZ) variants : Six phenotypes namely AA, BB, CC, AB, AC and BC at TZ locus are controlled by three alleles i.e. TZA, TZB and TZC. TZAC phenotypes were comparatively heavier body weight in broiler bird (Ahlawat, 1980).

I. Serum esterase variants : Pravakaran et al. (1985) reported serum esterase electrophoresis variants in five strains of chicken.

J. Erythrocyte catalase : Three sharply defined polymorphs of erythrocyte catalase had been observed. But no genetic data is yet available.

Conclusion

Most of the important non-immunogenic protein has some biochemical polymorphism. The economic traits like fertility, hatchability, body weight, age at sexual maturity, egg production and egg shell quality are more or less genetically correlated with polymorphs of different proteins. But the correlation between polymorphs of pre-albumin, erythrocyte catalase, plasma albumin, serum esterase and the reproductive trait has not yet found. Hatchability and fertility as affected by haemoglobin and transferrin polymorphism are to be noted. Serum alkaline phosphatase, transferrin and haemoglobin polymorphism affect the boy weight and egg production. In chicken differences in one blood group locus are associated with differences in rejection of skin homo-grafts and in another with susceptibility to infection by an avian leucosis sarcoma virus.

After all, at present a few demonstrations of apparent relationship of biochemical polymorphism to fertility, survivability and productivity remains one of the true puzzles of biology.

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