Indian Journal of Animal Sciences 66(2): 336-339, April 1996

Genetic determination of the lysozyme activity levels in guineafowl egg white and serum*

SANJAY KUMAR PAL[1], V K SAXENA[2] and HARPREET SINGH[3]

Central Avian Research Institute, Izatnagar, Uttar Pradesh 243 122

Received: 19 May 1995

ABSTRACT

Guineafowl lysozyme levels in egg white and serum revealed considerable quantitative variations between varieties and between sexes. Electrophoretic variants were not detected. Inheritance studies indicated significant genetic influences. Heritability values were 0.31±0.27 and 0.43±0.29, respectively, for lysozyme levels in serum and egg white. Moderate associations were observed for serum lysozyme with 4-week body weight, and for egg white lysozyme with age at first egg and albumin index.

Lysozyme (EC, 3.2.1.17), a widely distributed enzyme, is directly involved in antimicrobial defence mechanisms of body. Qualitative and quantitative variations of lysozyme activity in egg white and serum and its genetic control have been studied in chicken and other avian species (Baker *et al.* 1970, Manwell and Baker 1973, Sato and Watanabe 1976, Bessarabov and Krykanov 1985).

This article presents results of some observations on genetic control of quantitative and qualitative variations in guineafowl egg white and serum.

MATERIALS AND METHODS

Guncari guineafowls (370 individuals) belonging to 25 halfsib families maintained at this Institute were used. Lysozyme levels were assayed in fresh serum and egg white samples (Lie 1980, Lie *et al.* 1986). Qualitative variations were investigated in acrylamide-gel electrophoresis (Sato and Watanbe 1976).

Effects of genetic and nongenetic factors on lysozyme levels were investigated using the following statistical model in which the effect of sire was taken as random, and those of sex, feathering phenotypes and variety were taken as fixed effects.

$$Y_{ijkl} = \mu + M_i + S_j + F_k = P_l + e_{ijkl}$$

Where,

- Y_{ijkl} is the value of nth individual in ijklth cell,
- μ is the overall mean of the population,
- M_i is the effect of ith sire (i = 1, 2...n) (choosen at random),
- S_j is the effect of the jth sex (i = 1, 2),
- F_k is the effect of kth feathering phenotypes (k = 1, 2),
- P_l is the effect of 1th variety (1 = 1, ...3), and

*Part of the Ph. D. dissertation of the first author approved by the Indian Veterinary Research Institute (Deemed University), Izatnagar.

Present address: [1]Anadam, Chota Tangra, Kharagpur, West Bengal.

[2]Scientist, Central Institute for Research on Goats, Makhdoom, Uttar Pradesh 281 122.

[3]Principal Scientist.

e_{ijkl} is the environmental deviations attributed to individuals assumed to be normally distributed with mean 0 and variance σ^2.

RESULTS AND DISCUSSION

Existence of wide individual variations for lysozyme levels in egg white and other body fluids is well established among poultry species (Feeney and Allison 1969, Manwell and Baker 1973). In guineafowl serum lysozyme level at 4 weeks of age was 1.01 and 0.93 µg/ml, respectively, in male and female keets. A gradual increase at subsequent ages was seen in females. Significantly high lysozyme levels attained at maturity indicated higher cellular destruction taking place during the onset of laying (Fig. 1). Similar values were reported for chicken by Sato and Watanabe (1976). Differences between guineafowl varieties were significant, but effects of slow and rapid feathering phenotypes on lysozyme levels were not significant (Table 1). Population distribution pattern for lysozyme levels (8 weeks) revealed distinct bimodality (Fig. 2).

Table 1. Serum and egg white lysozyme least-square means for different varieties and feathering groups

	Lysozyme level	
	Serum (µgm/ml)	Egg white (mg/ml)
Varieties		
White	1.14±0.07[a] (68)	1.85±0.11 (40)
Lavender	1.26±0.06[b] (88)	1.79±0.02 (36)
Pearl	1.18±0.05[c] (114)	1.82±0.06 (114)
Feathering type		
Slow	1.15±0.05 (121)	1.78±0.07 (74)
Rapid	1.26±0.04 (149)	1.86±0.07 (116)
Overall	1.19±0.04 (270)	1.82±0.06 (190)

Figure in parenthesis is number of observations.

Mean egg white lysozyme levels are comparable to the earlier reported values for guineafowl by Valdimirova (1974) and Sajjnar (1993). But these estimates are relatively much lower than the values reported by Feeney and Allison (1969) and

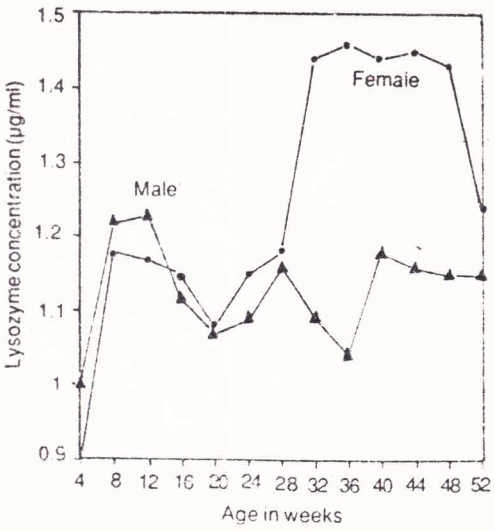

Fig. 1. Serum lysozyme levels in relation to age.

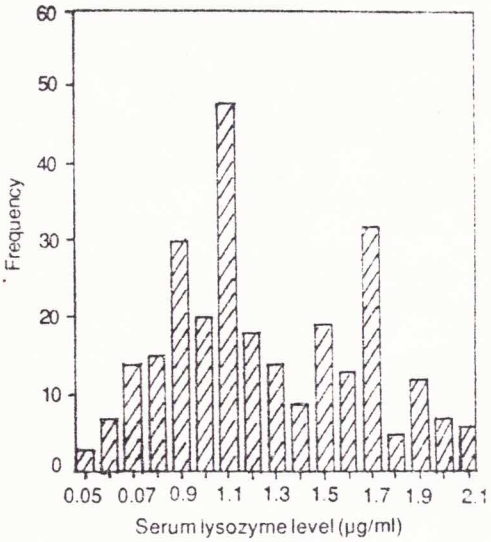

Fig. 2. Serum lysozyme distribution of GUNCARI population at 8 weeks.

Arora *et al.* (1974) for chicken. During electrophoresis, guineafowl egg white lysozyme resolved as a single discrete band between the quail and chicken lysozyme components (Fig. 3), but no variations were identified in this species.

Guineafowl serum and egg white lysozyme heritability estimates 0.311±0.27 and 0.428±0.294, respectively, are comparable to moderate heritability values reported for chicken (Bessarabov and Krykanov 1985). Inheritance of lysozyme levels among the progeny from matings between parents with high and low lysozyme levels indicated a dominance trend for high type over low type (Table 2). These observations imply existence of some major gene influences besides the limited additive gene control. Similar genetic control was reported for serum alkaline phosphatase (Tamaki 1975), and lysozyme levels (Lie *et al.* 1980). Low positive phenotypic and genetic correlations were obtained between serum lysozyme levels and body weights at hatch and 4 weeks of age (0.08, 0.02; 0.049±0.368, 0.329±0.459 respectively). Egg white lysozyme correlations with albumin index (0.59, 0.727±.0214) were positive but negative with age at first egg (-0.014, -0.683±0.278). In spite of the high standard errors obtained in a few cases, these associations indicated the possible trends and also suggested caution and further varification.

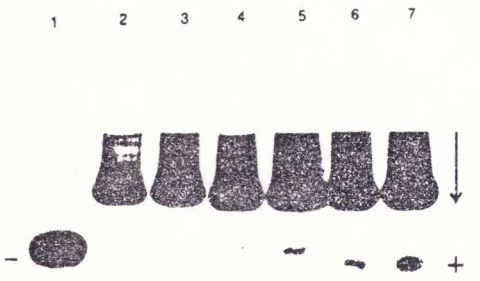

Fig. 3. Zymogram of egg white lysozyme 1, lysozyme standard, 2-3, guineafowl, 4-5 chicken, 6-7, quail.

Lysozyme defined as 1,4-ß-acetyl muramidase lyses bacteria by splitting the ß (1-4) linkage between N-acetlymuramic acid (NAG) N-acetyl-glucosomine component of its cell-wall. Released from blood platelets, lysozyme is an important nonspecific bacteriolytic agent in blood and other biological fluids. The sires arbitrarily classified as high, medium and low lysozyme level types revealed, respectively, 1.4, 4.5 and 6.2% mortality among their progeny. This negative association between lysozyme level of sire and progeny mortality pattern, positive correlations for body weights, and the negative correlation with age at first egg indicated a better health status for birds with higher lysozyme levels. These observations are in agreement

Table 2. Results for matings between parents with different serum lysozyme level (high-1.75, medium-1.4—1.2, low-1.0 µgm/ml)

Sire	Dam	N	Offspring (%)			Overall progeny average
			High	Medium	Low	
High	High	18	44.4	33.3	22.3	1.85
High	Low	23	21.7	43.4	34.9	1.31
Low	Low	28	10.7	32.1	57.2	0.95

with the report of a positive correlation between dam's lysozyme level and nonspecific general resistence of progeny (Bassarabov and Krykanov 1985). Efficient functioning of this highly evolved nonspecific defence system in egg white also seems crucial for resistance to microbial invasions of embryos (Sajjnar 1993). Observations of very low lysozyme levels in egg white of penguins and related birds as compared to high lysozyme levels observed among other avian species from relatively dirty habitats suggest existence of an evolutionary association with level of environmental pollution (Manwell and Baker 1972).

REFERENCES

Arora K L, Ameja D V and Chand D. 1974. A report on the lysozyme concentration in egg white of some breeds of fowl. *Indian Journal of Poultry Science* **53**: 162-64.

Baker C M A, Croizier G, Stratil A and Manwell C. 1970. Identity and nomenclature of some protein polymorphisms in chicken eggs and sera. *Advances in Genetics* **15**: 147-74.

Bessarabov B F and Krykanov A A. 1985. (The use of test of natural resistance in poultry breeding). Sbornik Nauchuykh Trudor. Veesoyuznyi Nauchno-Issla-dovatal SKIL. Institute Fiziologii Biolhimii i. *pltanii Sel Skokhozya Istvennykh Zhivotnykh* **31**: 139-42. (*fide Animal Breeding Abstracts* 8141.)

Feeney R E and Allison R G. 1969. Egg white proteins of different avian species. *Evolutionary Biochemistry of Proteins*. John Wiley and Sons, New York.

Lie O. 1980. Genetic variation in the serum lysozyme activity in cattle. *Acta Veterinaria Scandinevia* **21**: 448-50.

Lie O, Syed M and Solubu H. 1986. Improved agar plate assay of bovine lysozyme and haemolytic complement activity. *Acta Veterinaria Scandanevia* **27**: 23-32.

Manwell C and Baker C H A. 1973. Low level of lysozyme in egg white from the Fairy Penguin (E. Minor). *Acta Veterinaria Scandanevia* **115**: 586-89.

Sajjanar C M. 1993. 'Genetic studies on non-specific antimicrobial defences of guineafowl egg.' M. V. Sc. Thesis, Indian Veterinary Research Institute, Izatnagar.

Sato Y and Watanabe K. 1976. Lysozyme in hen blood serum. *Poultry Science* **55**: 1749-56.

Tamaki Y. 1975. Further strudies on the genetic control of chicken plasma alkaline phosphatase isozyme. *Animal Blood Groups and Biochemical Genetics* **6**: 195-200.

Valdimirova, Y U. 1974. The content of lysozyme in eggs of farm poultry. Proceedings of XV World Poultry Congress, New Orleans, pp. 634-35.