Immunocompetence Status of White Plumage Naked Neck versus Normally Feathered Broilers in Tropical Climate

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ABSTRACT : The study was undertaken to evaluate the effect of naked neck gene on mortality, cell mediated and humoral immune response in white plumage broiler population. The mortality of homozygous naked neck (Na/Na) broilers (11.71%) was comparatively lower than that of heterozygous naked neck (Na/na) (12.28%) and normally feathered (na/na) (13.59%) broilers. The humoral immune response was measured against (1% v/v) sheep red blood cells (SRBC) for total haemagglutinin (HA) antibody, 2-mercaptoethanol resistance (MER) or (IgG) antibody and 2-mercaptoethanol sensitive (MES) or (IgM) antibody titre on 7 days post-immunization. The titre was expressed as log2 of the highest dilution which shows complete haemagglutination. Total HA titers of Na/Na and Na/na (11.05±0.53 and 11.09±0.38) were comparatively higher than that of na/na (10.26±0.42). The MES antibody titre of Na/Na (8.50±0.53) and Na/na (7.63±0.45) broilers were significantly higher as compared to na/na (6.11±0.32) broilers. The MER titre of na/na genetic group (4.15±0.42) was significantly higher than Na/Na (2.55±0.37) and comparatively higher than Na/na (3.45±0.38) broilers. *In vivo* cell response to phytohaemagglutinin-P (PHA-P), measured as Foot Index (FI) in mm expressed significantly higher response in Na/na (0.473±0.05) and Na/Na (0.413±0.04) broilers as compared to na/na (0.304±0.03) broilers. The result of present study suggested that white plumage naked neck broilers had better immune response as compared to normally feathered broilers. ***(Asian-Aust. J. Anim. Sci. 2004. Vol 17, No. 4 : 560-563)***

Key Words : Naked Neck Broilers, Total Haemagglutinin (HA) Antibody, 2-Mercaptoethanol Resistance (MER) or (IgG) Antibody and 2-Mercaptoethanol Sensitive (MES) or (IgM) Antibody Titre, CMI Response

INTRODUCTION

Survivability, lower chick mortality and better adaptability of naked neck chicks in tropical climate have been reported by Smith and Lee (1977), Bordas et al. (1980), Horst (1980) and Khan (1998). The results of these studies suggested that there may be genetic differences with respect to antibody response in naked neck and normally feathered broilers. Variability in resistance to diseases exists almost in all species and the genetic mechanisms which control the resistance are correspondingly varied. There is considerable interest for identifying genetic markers which can be used for selection for general immunoresponsiveness (Gavora and Spencer, 1983). Immune response to a natural non-specific, non-pathogenic, multideterminant and T-cell dependent antigen like sheep red blood cells (SRBC) provides an indication of natural immunity (Vander Zijpp, 1983a; Saxena, 1997). Vander Zijpp and Leenstra (1980) estimated the total haemagglutinin (HA) antibody titre (log2), 2-mercaptoethanol resistance (MER) antibody titre (IgG) and 2 mercaptoethanol sensitive (MES) antibody titre (IgM) in 7 weeks old White Leghorn (WL) chickens. The *in vivo* response of lymphocytes to phytohaemagglutinin-P (PHA-P) and concanavalin-A (Con-A) was observed by Morrow and Abplanalb (1981). Lamont and Dietert (1990) reported polygenic control of antibody response and cell mediated immunity. Response to selection for high and low antibody titre to SRBC has been studied in chickens (Siegel and Gross, 1980). Martin et al. (1989) studied the IgG and IgM responses in high and low antibody selected lines of chicken. Significant effects of hatch, line, sex and B blood group haplotype on response to SRBCs have also been reported (Gross et al., 1980; Vander Zijpp and Leenstra, 1980; Pinard et al., 1992). Amongst the native Indian breeds, the naked neck had been reported for highest titre on day 5 Post Injection (PI) (Kundu et al., 1999). Nath et al. (2000) reported highest level of HA titre and Con-A response in crossbred and purebred for naked neck line in diallele experiment. The present study was undertaken to find out the effects of naked neck gene on mortality, humoral and cell mediated immune response in naked neck and normally feathered broilers.

MATERIALS AND METHODS

White plumage naked neck population (NNWP) of broilers available at Experimental Broiler Farm, CARI, Izatnagar was used in the present study. The naked neck white line was developed by crossing non-breed specific

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Table 1. Mean±SE (log2) of various immunological assays in naked neck and normally feathered broilers

Genotype	Sex	Obs.	HA	MER	MES
Na/Na	Male	15	10.46±0.40	2.66±0.39	7.80±0.47
	Female	5	12.80±1.60	2.20±0.96	10.60±1.28
	Pooled	20	11.05±0.53	2.55±0.37^{a}**	8.5±0.53^{a}**
Na/na	Male	15	10.86±0.41	3.26±0.52	7.60±0.47
	Female	7	11.57±0.84	3.85±0.50	7.71±1.08
	Pooled	22	11.09± 0.38	3.45±0.38^{ab}	7.63±0.45^{ab}**
na/na	Male	13	9.69±0.76	3.07±0.66	6.61±0.47
	Female	13	10.84±0.31	5.23±0.32	5.61±0.41
	Pooled	26	10.26±0.42	4.15±0.42^{c}**	6.11±0.32^{c}**

Values with no common superscripts (column wise) between genetic groups differ significantly (**p<0.01).

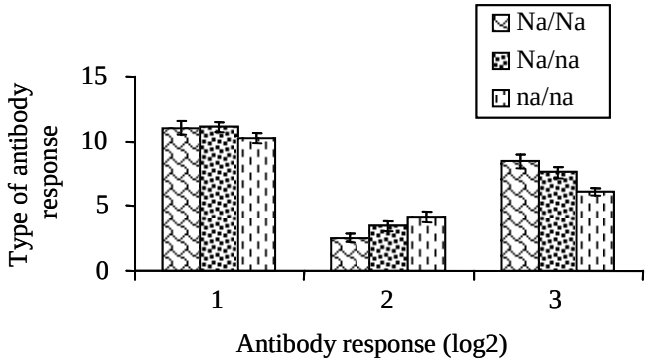

Figure 1. Mean anti SRBC total HA titre, 2-MER and 2-MES antibody titre for different genetic groups.

naked neck (body weight of approximately 400-500 g at 6 week age) and white synthetic broiler line. This population was backcrossed for five generations with synthetic broilers with aim to obtain a fast growing naked neck broiler. Mating between heterozygous (Na/na) males and females produced na/na, Na/na and Na/Na chicks. All the chicks were wing banded and divided in equal numbers over different pens and kept under uniform management conditions. Feed and water were provided *ad libitum* as per BIS (Bureau of Indian Standard) Specifications. Chicks of three genotypes and both sexes were tested for humoral immunity against SRBC immunization at 6 weeks. The microtitre procedure, as described by Siegel and Gross (1980) with slight modification was followed to measure HA antibody titre using 1% (v/v) SRBC in phosphate buffer saline. The mercaptoethanol resistance (MER) was estimated according to the method given by Martin et al. (1989) with slight modification on 7 day post injection. MES antibody titre on 7days post injection was estimated as the difference between the respective total and MER antibody titres. The titre was expressed as log2 of the highest dilution which shows complete haemagglutination. The *in vivo* T-cell mediated immune response to 1 mg% PHA-P was measured as FI in mm which determine as the difference between interdigital swelling values of PHA-P injected and control foot.

Statistical analysis

Data analysis was performed according to Snedecor and Cochran (1980) with the help of pre-prepared program in FORTRAN language. The differences between means were tested using student t-test.

RESULTS AND DISCUSSION

Na/Na broilers (Total no. 128) had lower mortality percentage (11.71%) as compared to Na/na (Total no. 357) (12.28%) and na/na (Total no. 206) broilers (13.59%). The means of total HA, MER and MES antibody titre have been presented in Table 1 and shown in Figure 1. Total HA titre in Na/na broilers showed the comparatively higher estimate as compared to na/na broilers but same as Na/Na broilers. The female broilers also showed non-significantly higher HA titre than the male broilers. Wide range of the estimates of total HA titre and its influence by various factor such as dose, route of injection, day of estimation, term of estimation and age etc. have been reported by various workers (Vander Zijpp 1983b; Ubosi et al., 1985; Kundu et al., 1999). But most of the reports showed lower estimates as compared to the results of present investigation (Siegel and Gross, 1980; Vander Zijpp and Leenstra, 1980; Kundu et al., 1999). The na/na broilers had significantly higher estimate of MER antibody titre than Na/Na and compared to Na/na broilers. Results of various studies suggested that the MER antibodies were commonly used as a measure of IgG antibody titre assuming that the destruction of SH bonds only affects the reactivity of IgM antibodies. The Na/Na and Na/na broilers also showed significantly higher titre of MES than na/na broilers but in general females had comparatively higher titre values than males.

The 2-mercaptoethanol treatment of serum has also been used by various workers (Martin et al., 1989; Haunsi, 1999) to estimate the MER and MES antibody titre as a measure of IgG and IgM antibody titre, respectively. The MER antibody response in naked neck broilers was significantly lower than na/na which was contradictory to the results reported by Haunshi (1999). He reported non-significant difference between naked neck as well as frizzle

Table 2. Mean±SE (mm) for anti PHA-P Cell Mediated Immune response in naked neck and normally feathered broilers

Genotype	Sex	Obs.	Response
Na/Na	Male	15	0.446±0.05
	Female	5	0.312±0.05
	Pooled	20	0.413 ± 0.04^{by}
Na/na	Male	13	0.471±0.07
	Female	5	0.478±0.11
	Pooled	18	0.473 ± 0.05^{ax}
na/na	Male	10	0.304±0.06
	Female	11	0.304± 0.04
	Pooled	21	0.304 ± 0.03^{cy}

Values with the different superscripts in the same column are significantly different ($^{a>b>c}$: p<0.05, $^{x>y}$: p<0.01).

birds with their respective normally feathered broilers. The mean MES antibody response was significantly higher in absolute term with the results reported by Vander Zijpp and Leenstra (1980).

Significantly higher Cell Mediated Immune (CMI) estimates were observed in Na/na and Na/Na broilers as compared to na/na (Table 2). Martin et al. (1989), Kundu (1999) and Haunshi (1999) reported non-significant effect of CMI response to Con-A on naked neck and frizzle gene. These findings were in agreement with Klingensmith et al. (1983), who reported higher cell mediated response of major genes (dwarf) in comparison to the normal birds.

The correlations among various immunocompetence traits like antibody response to SRBCs i.e. HA and MER antibody titre and *in vivo* response to PHA-P were estimated as simple product moment correlations among all the three genetic groups (Table 3). The correlation coefficient between total HA titre and MES antibody titre in Na/Na showed significantly positive value and this value was higher than in Na/na and na/na. The response in total HA titre on 7 dpi showed highly significant and positive relationship with MES antibody titre in Na/Na (0.755) and also had highest value than Na/na (0.588) and na/na (0.387) broilers. The response in MER antibody titre on 7 day PI was found negative and significantly (p<0.01) associated with MES antibody titre in Na/Na (-0.362) and also had the lowest value than Na/na (-0.601) and na/na (-0.387). The CMI response to PHA-P showed non-significant relationship with total HA antibody titre for all the three genotypes except na/na (-0.352) broilers, which is contradictory to the observation of Lassila et al. (1979), Vander Zijpp (1983b) and Haunshi (1999).

The results of present investigation suggested that the immunological assay revealed significantly higher natural antibodies, primarily of IgM types in naked neck broilers. However, the naked neck broilers had significantly lower IgG antibody titre as compared to normally feathered broilers but they had higher estimates of total HA antibody titre than the normally feathered broilers. CMI response was found significantly higher in naked neck broilers as compared to normal broilers.

Table 3. Correlation coefficient between different parameters of immune response to SRBC and PHA-P

Genotype		HA	MER	MES	PHA
Na/Na	HA	-	0.338	0.755**	0.175
	MER		-	-0.362	0.248
	MES			-	0.000
Na/na	HA	-	0.293	0.588**	0.126
	MER		-	-0.601**	0.082
	MES			-	0.040
na/na	HA	-	0.702**	0.387*	-0.352*
	MER		-	-0.387*	-0.246
	MES			-	-0.048

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REFERENCES

Bordas, A., L. E. Monnet and P. Merat. 1980. The naked neck gene, laying performance and nutritional efficiency at different temperature in the fowl. Annales de Genetique et de Selection Animale. 12:343-361.

Gavora, J. S. and J. Z. Spencer. 1983. Breeding for immune responsiveness and disease resistance. Anim. Blood Groups Biochem. Genet. 14:159-180.

Gross, W. B., P. B. Sigel, R. W. Hall, C. H. Domermuth and R. T. Duboise. 1980. Production and persistence of antibodies in chicken to sheep erythrocytes 2. Resistance to infectious disease. Poult. Sci. 59:205-210.

Haunshi, S. 1999. Studies on general immune competence in specialized chicken populations. M.V.Sc. Thesis submitted in Poultry Science, IVRI, Izatnagar, UP, India.

Horst, P. 1980. Genetical perspectives for poultry breeding on improved productive ability to tropical conditions. Second World Congress of Genetics Applied to Animal Production. 8:887-892.

Khan, A. A. 1998. Effect of naked neck gene on viability, performance and carcass fat of broilers. M.V.Sc. thesis submitted to IVRI, Izatnagar, UP, India.

Klingensmith, P. M., J. P. Donahoe and J. F. Stephens. 1983. The effect of sex linked dwarfing gene, *dw* on the immune response of broiler breeder chickens. Poult. Sci. 67(5):733-740.

Kundu, A., D. P. Singh, S. C. Mohapatra, B. B. Dash, R. P. Moudgal and G. S. Bisht. 1999. Antibody response to sheep erythrocytes in Indian native vis-à-vis imported breeds of chickens. Br. Poult. Sci. 40:40-43.

Lamont, S. J. and R. R. Dietert. 1990. New direction in poultry genetics. In: Poultry Breeding and Genetics. (Ed. R. D. Crawford), Elsevier Publication, New York.

Lassila, O., T. Nurmi and J. Eskola. 1979. Genetic differences in mitogenic response of peripheral lymphocytes in chickens. Journal of Immuno-genet. 6:37-43.

Martin, A., W. B. Gross and P. B. Siegel. 1989. IgG and IgM responses in high and low antibody selected lines of chickens. J. Heredity 80:249-252.

Morrow, P. R. and H. Abplanalp. 1981. Genetic control of T-lymphocyte mitogenesis in chicken. Immunogenetics. 13:189-200.

Nath, M., B. P. Singh, V. K. Saxena, A. K. Dev Roy and R. V. Singh. 2000. Humoral and cell mediated immune response in broilers. XXI World Poultry Congress. Montreal, Canada. 19-23 August.

Pinard, M. H., J. A. M. Van Arendonk, M. G. B. Nieuland and A. J. Vander Zijpp. 1992. Divergent selection for immune responsivness in chickens: Estimation of realized heritability with an animal model. J. Anim. Sci. 70:2986-2993.

Saxena, V. K., H. Singh, S. K. Pal and S. Kumar. 1997. Genetic studies on primary antibody response to sheep erythrocytes in guinea fowl. Br. Poult. Sci. 38:156-158.

Siegel, P. B. and W. B. Gross. 1980. Production and persistence of antibodies in chickens to sheep erythrocytes. I. Directional selection. Poult. Sci. 59:1-5.

Smith, L. T. and R. Lee. 1977. A study of naked neck gene of fowl. Poult. Sci. 56: 686-688.

Snedecor, G. W. and W. G. Cochran. 1980. Statistical Methods. 7th edition. Oxford & IBH.

Ubosi, C. O., W. B. Gross and P. B. Siegel. 1985. Divergent selection of chickens for antibody production to sheep erythrocytes. Age effect in parental lines and their crosses. Avian Dis. 29:150-158.

Vander Zijpp, A. J. 1983a. Breeding for immune responsiveness and disease resistance. World's Poult. Sci. J. 39:118-131.

Vander Zijpp, A. J. 1983b. The effect of genetic origin, source of antigen and dose of antigen on the immune response of cockerels. Poult. Sci. 62:205-211.

Vander Zijpp, A. J. and F. R. Leenstra. 1980. Genetic analysis of the humoral immune response of White Leghorn chicks. Poult. Sci. 59:1363-1369.