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# Immunocompetence traits and their association with production traits in CARI-Debendra chicken

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ABSTRACT

The immunocompetence (IC) status of any animal breed indicates about its general response to diseases. Single hatched CARI-Debendra (CD) chicks (84) were evaluated for IC traits (*in vivo* antibody response to SRBC, serum lysozyme and serum IgG concentrations) and their association with production traits in layer. According to least square mean analysis, the CD population contains HA titre, serum lysozyme and serum IgG concentration of 5.739±0.436, 6.031±0.213µg/ml and 5.999±0.347µg/µl, respectively. But, the sex of CD bird has no significant effect on all the IC traits. Phenotypic correlations between the IC traits were low. The level of HA titre had no significant effect on any of the production trait. Serum lysozyme level had significant effect on BW40 and serum IgG had significant effect on EW28. Birds with medium or low serum lysozyme level revealed higher BW40 than birds with high level. Birds with high serum IgG concentration demonstrated higher EW28 than birds with low and medium levels.

**Key words**: CARI-Debendra, Immunocompetence, Layer traits, Phenotypic correlation

Among several immunocompetence (IC) parameters, humoral immune response to sheep red blood cells (SRBCs) is an important parameter in poultry (Siegel and Gross 1980, Singh *et al.* 2010, Kumar and Kumar 2011). The SRBCs is a non-pathogenic multi-determinant antigen and birds with higher antibody response against SRBCs produce more antibodies to a variety of antigens (Parmentier *et al.* 1998). In addition, serum lysozyme a non-specific component of immune system plays an important role in body's defense against infection mediated through stimulatory effect on macrophages' phagocytic function as well as bacteriolytic action. Immunogloibulin-G (IgG) is the most abundant immunoglobulin in serum and is regarded as a good indicator of general immune response in birds (Pinard van der Laan *et al.* 1998).

CARI Debendra (CD), a multi-coloured, medium sized, dual purpose chicken, is suitable for rearing at rural backyard poultry production system. Furthermore, CD bird has revealed better survivability in field conditions. However, there is limited literature available on CD bird's IC profile and their association with performance traits. Therefore, the present investigation was carried out to evaluate humoral immune response, serum lysozyme and serum IgG concentration and assess their association with production traits in CD chicken.

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## MATERIALS AND METHODS

The experimental birds consisted of 84 single-hatched CD chicks reared at Institute's layer farm. Chicks were hatched out during Nov –Dec and initial vaccination was done in the hatchery itself at day-old stage, before transferring on to the litter brooder having adjustable hover fitted with single infrared lamp of 250 watt. At 4 weeks of age, chicks were shifted into new brooder house. Standard floor space and brooding temperature were provided. Chicks were provided with continuous light for 24 h in the first 3 weeks, which was decreased @ 2 h/week until 8 weeks. Feed and water was provided *ad lib.* 2 times daily. Chicks were vaccinated following standard vaccination programme being followed at this institute, viz. vaccination for Ranikhet and Marck's diseases at day-old, IBD on 14-day, RD booster on 28-day, IBD booster on 35-day and fowl pox at 42-day of age. SRBCs suspension was prepared by collecting approximately 20 ml of venous blood from Muzaffarnagari breed of sheep, reared at Sheep and Goat Farm of IVRI, Izatnagar.

The humoral immune response of chicks was assessed by estimating *in vivo* antibody response to SRBC on fifth day post-immunization by haemagglutination (HA) test at 5–6 weeks of age. One ml of 1% (v/v) sheep RBC suspension was injected into the jugular vein of each chick, sera were collected from approximately 1 ml of venous blood collected on fifth day post immunization (5 dpi), and stored at –20ºC until further analysis. The antibody response to SRBC was assessed using haemagglutination test (Van der Zijpp and Leenstra 1980), performed in round bottom (U shaped) microtitre plates, wherein 50 µl of phosphate buffered saline (PBS) was added in each well and 50 µl of serum samples were added in first well of each row except the last row where 50 µl of PBS was added; the last row acted as control. The sera were then 2-fold serially diluted and added with equal volume of 1% (v/v) SRBC suspension followed by thorough mixing and incubation at 37ºC for 1 h in a humid chamber. The highest dilution (n) of sera that yielded complete agglutination was recorded as titre and then expressed as $\log_2 n$ (Siegal and Gross 1980). The concentration of serum lysozyme and IgG was estimated by lysoplate assay (Lie *et al.* 1986) and single radial immunodiffusion (SRID) assay (Mancini *et al.* 1965), respectively. Data on IC traits was analyzed by least squares ANOVA (Harvey 1990) considering sex as a fixed effect in the model $Y_{jk}= \mu + W_j + e_{jk;}$ where, $Y_{jk}$,observation on $k^{th}$ individual of $j^{th}$ sex; µ, overall mean; $W_j$, fixed effect of $j^{th}$ sex; and $e_{jk}$, random error associated with mean zero and variance $\sigma^2$. Data on economic traits was analyzed to evaluate the effect of levels of IC traits using model $Y_{jk}= \mu + L_j + e_{jk;}$ where, $Y_{jk}$, observation on $k^{th}$ individual of $j^{th}$ level of IC trait; µ, overall mean; $L_j$, fixed effect of $j^{th}$ level of IC trait; and $e_{jk}$, random error associated with mean zero and variance $\sigma^2$. The independent variables in the model includes the levels of HA titre, serum lysozyme and IgG which were classified as high, medium and low based on their mean and standard deviation. A critical difference (CD) at 5 % level of confidence interval was considered to assess the effect of various levels of SRBC on each production trait.

Layer production traits, viz. AFE (age at first egg), BW20 (body weight at 20 weeks of age), EW28 (egg weight at 28 weeks of age), BW40 (body weight at 40 weeks of age), EW40 (egg weight at 40 weeks of age) and EP40 (egg production up to 40 weeks of age) were recorded on these birds, as approved for layer birds at this institute.

## RESULTS AND DISCUSSION

*Immunocompetence profile*

Influence of sex on various IC traits in CD birds, analysed by least squares analysis of variance revealed a non-significant effect on all the IC traits (Table 1). Although statistically nonsignificant, the males demonstrated higher estimates of HA titre, serum lysozyme and serum IgG concentration (Table 2).

Comparable estimate of HA titre was reported in Kadaknath chicken (Chatterjee *et al.* 2007). However, there was different HA titre value in synthetic dam line of broiler (Sivaraman *et al.* 2005) and Aseel chicken (Chatterjee *et al.* 2007) from the present study. This might be due to different genetic background of these chicken populations (Singh *et al.* 2010). Similarly, estimates for serum lysozyme concentration in White Leghorn (Shivakumar 2003) and Aseel (Kumar and Kumar 2011) were not consistent with our findings. The IgG concentration in CD population was consistent with synthetic dam line of broiler's IgG (Sivaraman *et al.* 2005) but, lower than the Aseel (Singh *et al.* 2010).

*Influence of sex on various immunocompetence traits*

The effect of sex on the studied IC traits was non-significant at $P< 0.05$ in our study (Tables 2) and it was in accordance with the findings of Sivaraman *et al.* (2005) and Kumar and Kumar (2011). Although statistically non-significant, least squares means of all 3 IC traits were higher in males than in females in the present study. Similar results on serum IgG concentration were also examined for Aseel breeds by Kumar (2006). These current results indicated that the genetic mechanisms responsible for mounting of antibody

Table 1. Least squares analysis of variance of immunocompetence traits in CARI-Debendra crossbred chicken

| Source of variation | df | Mean sum of squares | | |
|---|---|---|---|---|
| | | HA[1] titre | Serum lysozyme conc. | Serum IgG conc. |
| Sex | 1 | 17.010 | 0.116 (1) | 0.939 (1) |
| Remainder | 79 | 15.195 | 3.787 (82) | 7.211 (58) |

Figures within parenthesis denote degrees of freedom.[1]Haemeagglutination.

Table 2. Least squares means±standard errors of immunocompetence traits in CARI-Debendra crossbred chicken

| Factor | HA[1] titre | Serum lysozyme conc. (µg/ml) | Serum IgG conc. (µg/µl) |
|---|---|---|---|
| Overall | 5.739±0.436 (81) | 6.031±0.213 (84) | 5.999±0.347 (60) |
| Male | 6.200±0.581 (45) | 6.068±0.293 (44) | 6.124±0.482 (31) |
| Female | 5.278±0.650 (36) | 5.993±0.308 (40) | 5.874±0.499 (29) |

Figures within parenthesis denote number of observations. [1]Haemeagglutination.

response to SRBC and regulation of serum lysozyme and serum IgG levels might be sex-independent.

*Phenotypic correlations ($r_p$) among various immuno-competence traits*

The phenotypic correlation ($r_P$) was negative between HA titre and serum lysozyme concentration (–0.215) and serum lysozyme and serum IgG concentration (–0.117), but, positive between HA titre and serum IgG concentration (0.055). These traits may be considered while selecting for improvement in general immune responsiveness. There was no definite trend in $r_P$ magnitude which might be due to small sample sizes. Small and negative $r_p$ between the IC traits were also reported by previous workers (Kean *et al.* 1994, Kumar 2006). Moreover, lower and inconsistent estimates of $r_P$ for the IC traits were reported in various chicken populations between HA and serum lysozyme concentration (Shivakumar 2003, Kumar 2006), between HA and serum IgG concentration (Shivakumar 2003) and between serum lysozyme and serum IgG concentration (Sivaraman *et al.* 2005).

*Association of IC traits with layer production traits*

Various layer production traits were affected by levels of different IC traits, viz. body weight at 20 weeks of age by serum lysozyme concentration (P<0.06), EW28 by serum IgG concentration (P<0.05), BW40 by serum lysozyme concentration (P<0.05) and EW40 by serum IgG concentration (P<0.10) in CD birds (Table 3).

The body weight of birds at 40 weeks of age containing low or medium serum lysozyme level revealed comparatively heavier body weight than the birds having high lysozyme level (P < 0.05). On the contrary, the egg weight laid by the hen at the age of 28 weeks was significantly heavier for those hens containing high serum IgG level than low or medium IgG level at P< 0.05 (Table 4).

Table 3. Effect of levels of IC traits on layer production traits in CARI-Debendra crossbred chicken

| Source of variation | df | Mean sum of squares | | | | | |
|---|---|---|---|---|---|---|---|
| | | BW20 | AFE | EW28 | BW40 | EW40 | EP40 |
| HA titre | | | | | | | |
| Levels | 2 | 43243.5 | 246.5 | 2.1 | 49084.0 | 1.0 | 322.0 |
| Remainder | 36 | 109120.9 | 349.8 | 14.9 | 64040.8 | 15.4 | 252.9 |
| Serum lysozyme Conc. | | | | | | | |
| Levels | 2 | 292910.7¥ | 262.5 | 18.7 | 197624.8* | 9.3 | 247.6 |
| Remainder | 36 | 95250.5 | 348.9 | 13.9 | 55788.5 | 15.0 | 257.1 |
| Serum IgG | | | | | | | |
| Levels | 2 | 175591.0 | 240.2 | 47.7* | 64678.7 | 32.9£ | 90.4 |
| Remainder | 36 | 101768.3 | 350.2 | 12.3 | 63174.4 | 13.7 | 265.8 |

£P≤0.10, ¥P<0.06, *P<0.05. HA, Haemeagglutination; IgG, immunoglobulin-G; BW20, body weight at 20 weeks of age; AFE, age at first egg; EW28, egg weight at 28 weeks of age; BW40, body weight at 40 weeks of age; EW40, egg weight at 40 weeks of age; and EP40, egg production up to 40 weeks of age.

Table 4. Least squares means±standard errors of various economic traits in CARI-Debendra crossbred chickens

| Factors | Obs. | Least squares means±standard errors | | | | | |
|---|---|---|---|---|---|---|---|
| | | BW20 | AFE | EW28 | BW40 | EW40 | EP40 |
| *HA titre* | | | | | | | |
| Low | 1 | 2500.0±330.34 | 145.00±8.70 | 49.00±3.86 | 2750.0±253.06 | 55.00±3.93 | 53.00±15.90 |
| Medium | 28 | 2200.9±62.43 | 162.82±3.54 | 48.48±0.73 | 2433.9±47.82 | 55.65±0.74 | 74.46±3.01 |
| High | 10 | 2215.0±104.46 | 157.20±5.92 | 47.760±1.22 | 2460.0±80.03 | 56.09±1.24 | 78.90±5.03 |
| *Serum lysozyme concentration* | | | | | | | |
| Low | 7 | 2185.7±116.65 | 160.00±7.06 | 49.66±1.41 | 2427.1±89.27$^{ab}$ | 56.33±1.46 | 82.00±6.06 |
| Medium | 23 | 2302.2±64.35 | 158.61±3.90 | 48.53±0.78 | 2522.6±49.25$^{a}$ | 56.06±0.81 | 72.52±3.34 |
| High | 9 | 2002.8±102.88 | 167.56±6.23 | 46.69±1.25 | 2276.7±78.73$^{b}$ | 54.50±1.29 | 76.11±5.34 |
| *Serum IgG concentration* | | | | | | | |
| Low | 10 | 2177.5±100.88 | 166.90±5.92 | 47.09±1.11$^{b}$ | 2403.0±79.48 | 53.70±1.17 | 78.40±5.16 |
| Medium | 21 | 2290.5±69.61 | 158.86±4.08 | 47.73±0.77$^{b}$ | 2501.0±54.85 | 56.81±0.81 | 74.52±3.56 |
| High | 8 | 2050.0±112.79 | 158.88±6.62 | 51.34±1.24$^{a}$ | 2368.8±88.86 | 55.53±1.31 | 72.25±5.76 |

Means within a column in a trait having different superscripts differ significantly (P<0.05). HA, Haemeagglutination; IgG, immunoglobulin-G; BW20, body weight at 20 weeks of age; AFE, age at first egg; EW28, egg weight at 28 weeks of age; BW40, body weight at 40 weeks of age; EW40, egg weight at 40 weeks of age; and EP40, egg production up to 40 weeks of age.

The present investigation revealed that the level of HA titre has no significant effect on production traits (P>0.05). But, Van der Zijpp and Nieuwland (1986) reported higher egg number and egg weight for those birds containing high HA titre than the low HA titre in ISA warren chicken line. Moreover, the birds with lower body weight at 38$^{th}$ week of age contained high HA response to SRBC than the control and low HA (Parmentier *et al.*1998).

CARI-Debendra chicken demonstrated better immunocompetence profile and it was not affected by sex of the birds. The phenotypic correlation among immunocompetence traits was low. The level of HA titre had no significant effect on any of the production trait. Serum lysozyme level had significant effect (P≤0.05) on body weight at 40 weeks of age (BW40) and serum IgG had significant effect (P≤0.05) on egg weight 28 weeks of age (EW28). Birds with medium or low serum lysozyme level revealed higher BW40 than birds with high level. Birds with high serum IgG concentration demonstrated higher EW28 than birds with low and medium levels. The information generated in this investigation may be useful in chalking out programmes for simultaneous genetic improvement in the production traits along with immunocompetence traits.

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