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Immunocompetence based scoring index for evaluating disease resistance status in indigenous and exotic breeds of chicken

A KUNDU[1], D P SINGH[2] and S C MOHAPATRA[3]

ICAR-Central Avian Research Institute, Izatnagar, Uttar Pradesh 243 122 India

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ABSTRACT

Birds (433) of both sexes developed from 8 genetically diverse lines of chickens like Aseel, Kadakanath, Naked Neck and Frizzle fowl along with imported breeds Dahlem Red, White Leghorn, Synthetic Dan Line broiler (SDL) and Naked Neck broiler (NNB) were evaluated for immunocompetence traits, viz. haemagglutinin test (HA), mercaptoethanol resistant (MER or IgG), classical pathway (CPW) and alternate pathway (APW) response to sheep red blood cells (SRBCs) at 0, 5, 12 and 19 days post immunization (pi), CMI response (as foot index against PHA-P), phagocytic index (PI) using carbon clearance test. Per cent mortality was also recorded based on whole hatch from which sample birds were drawn for each group from 0–20 weeks of age. Based on the results of immunocompetence traits, a scoring index was formed and various genotypes were ranked. Dahlem Red exhibited highest HA response followed by indigenous breeds. SDL broilers and White Leghorns ranked lowest for HA response. Dahlem Red excelled all other genetic stocks for IgG, FI and only next in order to Aseel and Kadakanath for CPW and APW. The index was constructed giving equal weightage to each of the traits. Broilers and White Leghorns, which ranked lowest, exhibited highest mortality.

Key words: Exotic birds scoring index, Immunocompetence, Indigenous birds scoring index, Mortality, Sheep red blood cells

Selection index evaluates an individual for its aggregate genotype. Many attempts were made to construct weight free immunocompetence index utilizing measurable immunological parameters. Cheng and Lamont (1990) developed a selection index based on phagocytosis, cell mediated immune response (response to PHA-P) and antibody production for 2 vaccines. The selection index was constructed on the assumption that genetic correlation between these traits is negligible. The economic values of these traits were calculated and found to be negatively proportional to heritability values. After 2 generations of selection, significant differences were observed between high and low response of lines for humoral and cellular immunity. Sivaraman and Kumar (2006) observed significant difference between lines and sex. Sivaraman and Kumar (2010) suggested use of immunocompetence based selection index along with other economic traits for improvement of immunoresponsiveness.

Similar selection indices based on immunological traits were also developed for improvement of general disease resistance. Almid (1981) proposed an index for resistance to infectious diseases in dairy bulls; Buchmann and Meyer (1989) suggested a procedure for selecting pigs to create an index of immune competence; Hersh *et al.* (1981) proposed a system to evaluate host defense mechanism to control the therapy of human cancer; Meyer (1981) used the immune response as selection criteria in pigs; Pavel *et al*. (1980) developed a genotype index of response against *E. coli* and *Staph. aureus*, lysozyme activity and phagocytic activity; Ulo (1979) developed non-specific resistance index; Val'Daman (1984) developed an index of natural resistance in chicken.

Kean *et al.* (1994) selected White Leghorn lines based on (i) antibody production to vaccines; (ii) reticuloendothelial clearance; (iii) cell-mediated wing web response to PHA; (iv) average heritability estimates; and pooled across 3 generations (2 cycles of selection), estimated by using sire variance components and parent offspring correlations which were 0.16 and 0.09 respectively, for the index.

Scientific information on the immunocompetence based total scoring index of indigenous breeds of chicken, believed to be resistant to many infectious diseases is scarce. The present investigation was designed and conducted to generate information on immunocompetence based total scoring index utilizing the data generated earlier (Kundu *et al.* 1997, 1999, 2000, 2015a,b,c) on immunological traits

Present address: [1]Principal Scientist and Head (drakundu1@yahoo.com), Animal Science Division, CIARI, Port Blair. [2]Principal Scientist (dpscari06@gmail.com), [3]Ex-Director (scm3642@yahoo.com).

representing 3 functional facets of immune system such as humoral immune response to sheep red blood cells (SRBC), haemagglutinin antibody (HA), mercaptoethanol resistant or MER (IgG) and complement response (classical or CPW, alternate pathway or APW) on different days (0,5,12,19) of post immunization, cell mediated immune response as foot index (FI) to phytohaemagglutinin- P (PHA-P) phagocytosis as phagocytic index. Percent mortality was also recorded and calculated from 0–20 weeks of age.

MATERIALS AND METHODS

The innate immunocompetence traits of various indigenous and exotic breeds of chicken were measured against SRBC immunization at 7 weeks of age. Chickens (433), 7-week-old, of both sexes from 8 chicken lines, viz. indigenous (215), Aseel (44), Kadakanath (69), Naked Neck (53) and Frizzle (49), Dahlem Red (49), White Leghorn (80), Synthetic Dam Line (SDL) broiler (43) and Naked Neck (NN) broiler (46) were chosen to be tested for general immunocompetence against SRBC immunization by means of Anti SRBC antibody response, viz. haemagglutinin antibody (HA) titre as per Siegel and Gross (1980) with slight modification (Kundu *et al.* 1998), Mercaptoethanol resistant (MER) antibody titre or IgG, at days 0, 5, 12 and 19 post immunization (dpi) of sheep red blood cells (SRBCs) at the dose of 1 ml of 25% volume/volume SRBC suspension in phosphate buffer saline (PBS) intramuscularly in thigh muscles. *In-vivo* cellular mediated immune response (CMI) was measured by 0.1 ml of phytohaemagglutinin-P (PHA-P) injection interdigitally between the third and fourth toe of the right foot of each chicken as foot index (FI) or skin index following the method of Cheng and Lamont (1988). Anti-SRBC complement response was measured at days 0, 5, 12 and 19 post immunization of SRBCs in each chicken by means of calcium dependent pathway or classical pathway (CPW) and calcium independent pathway or alternate pathway (APW) titres (CH_{50} unit/ml) as per Demey *et al.* (*fide* Baelmans 1996, personal Communication). Reticuloendothelial carbon clearance was measured for determining the phagocytic activity as phagocytic index (Cheng and Lamont 1988). It was measured at 10 – 11 weeks of age using intravenous injection of colloidal carbon.

Mortality was recorded from 0–20 weeks of age on Aseel (143), Kadakanath (251) Naked Neck (116), Frizzle (59), Dahlem Red (178), White Leghorn (87), SDL broiler (50)

Table 1. Scoring index based on various immunocompetence traits and mortality percent in various genetic lines of chicken

Immunocompetence traits	dpi	Genotypes							
		Aseel	Kadakanath	Naked Neck	Frizzle	Dahlem Red	White Leghorn	SDL broiler	NN broiler
HA response	0	1	6	6	6	6	8	8	2
	5	4	4	4	6	1	5	8	8
	12	5	5	7	7	1	7	8	8
	19	4	6	8	7	1	8	8	7
Total score		14	21	25	26	9	28	32	25
(Avg score)		(3.5)	(5.3)	(6.3)	(6.5)	(2.3)	(7.0)	(8.0)	(6.3)
IgG response	0	3	3	5	1	3	5	8	7
	5	8	8	6	6	1	7	8	8
	12	6	5	7	7	1	8	8	8
	19	2	4	8	8	1	8	8	8
Total score	19	20	26	22	6	28	32	31	
(Avg score)	(4.8)	(5.0)	(6.5)	(5.5)	(1.5)	(7.0)	(8.0)	(7.8)	
CPW response	0	4	3	4	6	1	4	8	8
	5	1	1	4	7	1	5	7	8
	12	1	1	6	7	6	6	8	8
	19	1	5	8	7	8	7	8	8
Total score (Avg score)		7(1.8)	10(2.5)	22(5.5)	27(6.8)	16(4.0)	22(5.5)	31(7.8)	32(8.0)
APW response	0	1	3	6	7	3	6	8	8
	5	1	4	6	8	4	6	8	8
	12	1	5	7	8	7	7	8	8
	19	1	6	8	8	8	8	8	8
Total score (Avg. score)		4(1.0)	18(4.5)	27(6.8)	31(7.8)	22(5.5)	27(6.8)	32(8.0)	32(8.0)
FI		6	3	5	6	1	8	6	8
PI		8	8	8	1	8	7	8	8
Total imm.comp. score		58(3.2)	80(4.4)	113(6.3)	113(6.3)	62(3.4)	120(6.6)	141(7.8)	136(7.5)
Percent mortality	0–5wk	6	1	5	6	4	8	8	8
	6–10wk	6	1	8	8	3	7	8	7
Total score		12(6.0)	2(1.0)	13(6.5)	14(7.0)	7(3.5)	15(7.5)	16(8.0)	15(7.5)
Overall score + mortality		70	82	126	127	69	135	157	141

Naked Neck broiler (50) chickens for the whole hatch from where samples of birds were randomly chosen for immunocompetence study.

Based on the result of immunocompetence traits obtained in this study, the values were scored to form an index and ranked the various genotypes for different types of immune response. For scoring, a subjective index of 1–9 was developed. Scoring was done as follows:

Status/response	Symbol	Scores
High – high	HH	1
High – medium	HM	2
High – low	HL	3
Medium – high	HH	4
Medium –medium	MM	5
Medium – low	ML	6
Low-high	LH	7
Low-medium	LM	8
Low – low	LL	9

RESULT AND DISCUSSION

Based on result of immunocompetence traits, an attempt was made for scoring these values into an index and ranking the various genotypes for different types of immune response. For scoring, a subjective index of 1–9 was developed. Scoring of the each genotype for various type of immune response along with procedure followed for scoring is presented in Table 1. Dahlem Red exhibited highest HA response followed by indigenous breeds (Fig. 1). SDL broilers and White Leghorn ranked lowest for HA response. Dahlem red also excelled all other genetic stocks for IgG and FI, and only next to Aseel and Kadakanath for CPW and APW. However, when all the immunocompetence traits were considered together in the form of an index (total score), Aseel excelled all the other genetic groups followed by Dahlem Red. Broilers were least efficient in the overall ranking, followed by White Leghorns. Our study suggested that high producing stocks are least efficient with respect to immune system probably due to the stress imposed for high productivity. With respect to mortality, Kadakanath was more resistant compared to other genetic groups. Ranking of the genotypes for mortality was also lower for broilers followed by White Leghorn. Different components of immune system are specifically directed to combat against pathogenic organisms and to increase resistance to diseases. Very little information is available in literature about the relative importance of the different immunological traits for achieving their goals. The index described above was therefore developed with equal weight age to each of the traits. It may be stated that although high level of different immunological traits are expected to provide more resistance against infection, extremely high level of immune effectors like complement levels, immunoglobulins may lead to auto immune conditions. It may be seen that Assel, which was ranked as number one, did not have least mortality although it had highest egg production compared to all other genetic groups. On the other hand, Broilers and White Leghorn, which ranked lowest, exhibited highest mortality. Scoring of the genotypes for their overall immunocompetence indicated that high producing stock is least efficient with respect to immunological response.

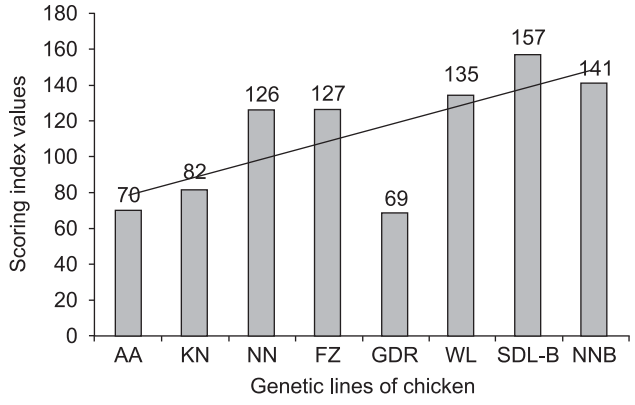

Fig. 1. Overall scoring index values of various genetic lines of chicken. Aseel (AA), Kadakanath (KN), Naked Neck (NN), Frizzle (FZ), Averaged for Indigenous chicken (IND.O), German Dahlem Red (GDR), White Leghor n (WL), SDL broiler (SDL-B), Naked Neck broilers (NN-B), averaged for broilers (BRO.O).

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