Comparative evaluation of immune-responsiveness in indigenous and exotic breeds of chicken

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Abstract

In this research we conducted a comparative study of immune responsive traits for the two exotic chicken breeds viz. Australorp and Cornish with one of the indigenous Kadaknath chicken breeds. Immune response to Sheep Red Blood Cells (SRBC) was measured in terms of Haemagglutination Titre (HA) and Haemagglutination Inhibition titre (HI) at five stages viz; 0 (pre inoculation), 3rd, 6th, 9th and 12th days post primary inoculation (PPI) of SRBC. The HA titre was significantly (P<0.05) higher in the native breed Kadaknath at all the five stages. The in-vivo cell mediated response to mitogen phytohaemagglutinin was higher in Kadaknath chicken as compared to exotic chicken. The native Kadaknath breed has stood out over Australorp and Cornish for generation of humoral and cell mediated immune response and it indicates that the indigenous breeds have considerable potential to reduce susceptibility to infectious diseases.

Keywords: Chicken, immunocompetence, sheep red blood, phytohaemagglutinin, Kadaknath, Australorp, Cornish

Introduction

Today, poultry farming is the fastest growing agricultural industry in India. The indigenous breeds of chicken in India plays an important role in marginal or rural people where they get nutrition from chicken and subsidiary income by rearing them as backyard poultry farming. According to 20th livestock census the total poultry has increased by 16.81 % while over 45.79% increases has occurred in backyard poultry during 2019 (www.dahd.nic.in) [1]. Losses due to infectious diseases are the major factor resulting in economic loss in worldwide poultry production. The immune system is the natural way by which animals cope up with infections, and the immunological parameters may reveal the immuno-competence of the immune system for an individual. Incorporation of genetic resistance has several advantages including the enhancement of immune response to vaccines (Gavora and Spencer. 1979) [2]. The immune system of birds consists of three basic sub-systems, the humoral, cellular and phagocytic. The antigens which are causative agents of disease are used to challenge the birds for evaluation of immune responsive traits. One of the appropriate ways to challenge the birds is with non-pathogenic, non-specific antigens. The ability of the chicken to produce antibodies can be exhibited by the response by antibodies to sheep red blood cells (SRBCs) (Siegel and Gross, 1980) [3]. In this regard, immune response to a natural, non-specific, non-pathogenic and multi-determinant antigen like sheep red blood cells (SRBC) is widely used to study the immune competence in poultry (Van der Zijpp et al., 1983) [4]. India has a rich source of native chicken breeds, A few reports are available in literature on the immune responsive traits in exotic and indigenous breeds of chickens (Sivaraman et al., 2005) [5] and rare in Kadaknath native chicken (Singh et al., 2009) [6]. Therefore, the present research was carried out to evaluate immune responsive traits in exotic and indigenous breeds of chicken and to find out the suitability of rearing of chicken with minimizing the economic loss due to health.

Materials and Methods

Thirty birds of each breed, being maintained at livestock farm complex of Post Graduate Institute of Veterinary Education and Research, Jaipur (Rajasthan), India during 2018 were selected randomly and used in present investigation.
The immune response traits were estimated at the age of 6-7 weeks by two methods: humoral immune response to sheep red blood cells (SRBC) and by in-vivo cell mediated immune response to mitogen phytohaemagglutinin. The antibody response to SRBC was assessed using haemagglutination test (Van der Zijpp and Leenstra, 1980) [7] and haemagglutination inhibition test (Miller et al. 1992) [8]. In-vivo cell mediated immune response to phytohaemagglutinin was evaluated as per the method outlined by Cheng and Lamont (1988) [9] using footpad response to Mitogen PHA-P. Data collected on immunological trait were subjected to analysis of variance (ANOVA) by generalized linear model using IBM Statistical package SPSS version 25.0 [10]. The significance of difference between breeds for different traits was evaluated by Duncan’s multiple range tests.

Results and Discussion

Immune response to Sheep Red Blood Cells

Immune response to sheep red blood cells (SRBC) was estimate in terms of haemagglutination titre (HA) in all the three breeds at five stages viz; 0 (pre inoculation), 3<sup>rd</sup>, 6<sup>th</sup>, 9<sup>th</sup> and 12<sup>th</sup> days post primary inoculation (PPI) of SRBC. Haemagglutination titre gives the indication of total antibodies produced in the immune response. The mean with standard errors (± S.E) for antibody response (HA titre) expressed as log<sub>2</sub> for different exotic and indigenous breeds are presented in Table 1. It is evident that all the three breeds possessed natural antibodies. The difference among the breeds were significantly different at (P<0.05)

Kundu et al. (1999a) [11] and Chatterjee et al. (2007) [13] reported higher values of response to SRBC in Kadaknath on 5<sup>th</sup> day post immunization than the present study. Saxena et al. (2012) [14] estimated response to SRBC in Kadaknath on 5<sup>th</sup> days post immunization as 1.52±0.068. The indigenous breed Kadaknath showed significant difference (P<0.05) from exotic breeds. At 9<sup>th</sup> day and 12<sup>th</sup> day post immunization all the three breeds showed slight decrease in titre values. Kadaknath breed showed highest response followed by Cornish and Australorp. Singh et al. (2009) [6] conducted comparative study of immune response to sheep red blood cells in exotic pure (white leghorn and RIR) and crossbred chicken and HA titre was found significantly higher on day 10 in both the breeds. The estimated immune response to Sheep Red Blood Cells (SRBC) in terms of haemagglutination Inhibition titre (HI) at four stages viz; 3<sup>rd</sup>, 6<sup>th</sup>, 9<sup>th</sup> and 12<sup>th</sup> day PPI of SRBC is presented in Table 2. The results showed that highest Mercaptoethanol Resistant antibody titre value was obtained by Kadaknath followed by Australorp and Cornish except at 12<sup>th</sup> day post immunization which was higher in Cornish. Figure 2 illustrated that the native Kadaknath breed showed highest production of IgG at 3<sup>rd</sup>, 6<sup>th</sup>, 9<sup>th</sup> and 12<sup>th</sup> days post primary inoculation (PPI) of SRBC. Response at 3 day post immunization was highest in Kadaknath while exotic breeds attained highest values on day 6<sup>th</sup> day of post immunization (Figure 1).

The results are in corroboration with the earlier studies among divergent indigenous and imported stocks of chicken for natural antibodies (Kundu et al., 1999a) [11]. A similar finding was observed by Pathak et al. (2017) [12] for 0 day pre-inoculation titre in Kadaknath. The HA titre increased post primary inoculation in both the exotic and indigenous breeds and attained highest values on day 6<sup>th</sup> day of post immunization.

### Table 1: Total antibody titers (Mean±SE) before and after primary inoculation of sheep red blood cells in HA titre

| Days Post Immunization | Exotic Breeds | Indigenous Breed |
|------------------------|--------------|------------------|
|                        | Australorp  | Cornish          | Kadaknath      |
|                        | Mean± S.E   | Mean± S.E        | Mean± S.E      |
| 0 Day Base Titre       | 0.27±.0.09  | 0.12±±0.06       | 0.34±±0.08     |
| 3 Day                  | 1.76±±0.11  | 3.89±±0.26       | 5.24±±0.27     |
| 6 Day                  | 5.24±±0.25  | 5.15±±0.29       | 6.79±±0.23     |
| 9 Day                  | 5.00±±0.24  | 5.04±±0.30       | 6.75±±0.26     |
| 12 Day                 | 1.79±±0.15  | 2.81±±0.20       | 3.65±±0.15     |

<sup>a,b,c</sup>Means in the same row with different superscripts letters (a, b, c) were significantly different at (P<0.05)

### Table 2: Total antibody titers (Mean±SE) before and after primary inoculation of sheep red blood cells in HI titre

| Days Post Immunization | Exotic Breeds | Indigenous Breed |
|------------------------|--------------|------------------|
|                        | Australorp  | Cornish          | Kadaknath      |
|                        | Mean± S.E   | Mean± S.E        | Mean± S.E      |
| 3 Day                  | 0.38±±0.09  | 0.15±±0.16       | 4.24±±0.10     |
| 6 Day                  | 1.55±±0.09  | 1.30±±0.17       | 5.62±±0.16     |
| 9 Day                  | 2.52±±0.29  | 2.08±±0.19       | 5.00±±0.17     |
| 12 Day                 | 0.45±±0.09  | 0.67±±0.107      | 2.72±±0.13     |

<sup>a,b</sup>Means in the same row with different superscripts letters (a, b) were significantly different at (P<0.05)

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Fig 1: Antibody titres at different periods given primary inoculation of Sheep Red Blood in HA titre
Kundu et al. (1999b) [15] also reported the similar results for native chicken breeds. Natural IgG antibodies were present in all breeds as indicated by base titre value at 0 day. The high IgG levels were observed during first two weeks of age which declined rapidly till fourth week of age and finally attained a static level (Figure 2). Martin et al. (1989) [16] studied IgM and IgG response in high and low antibody in selected lines of chicken and observed total antibodies increased rapidly, attained peak and persisted at moderate level in high antibody selected line.

The mean±SE values of Mercaptoethanol Sensitive Antibody titre (MES), representing the Ig isotype was also analysed by the difference of total antibody and presented in Table 3.

Table 3: Mercaptoethanol Sensitive Antibody titre (Mean±SE) titers at different periods after primary inoculation of Sheep Red Blood Cells

| Days Post Immunization | Exotic Breeds | Indigenous Breed |
|------------------------|---------------|------------------|
|                        | Australorp  | Cornish | Kadaknath  | Australorp  | Cornish | Kadaknath  |
|                        | Mean± S.E.  | Mean± S.E. | Mean± S.E. | Mean± S.E.  | Mean± S.E. | Mean± S.E. |
| 3 Day                  | 1.33b±0.15  | 3.74a±0.30 | 1.00b±0.25 | 1.38b±0.15 | 3.85a±0.31 | 1.37b±0.13 |
| 6 Day                  | 3.69a±0.25  | 3.85a±0.31 | 1.37b±0.13 | 3.85a±0.31 | 3.85a±0.31 | 1.37b±0.13 |
| 9 Day                  | 2.48a±0.26  | 2.96a±0.32 | 1.89b±0.24 | 2.96a±0.32 | 3.85a±0.31 | 1.37b±0.13 |
| 12 Day                 | 1.34b±0.15  | 2.27a±0.21 | 1.03b±0.20 | 2.27a±0.21 | 3.85a±0.31 | 1.37b±0.13 |

a, b Mean in the same row with different superscripts letters (a, b) were significantly different at (P<0.05)

The majority of antibodies during a primary immune response are of class Ig. Ig has the ability to easily agglutinate large antigens and to cause the precipitation of soluble antigens, thus greatly enhancing the immune system’s ability to remove antigens through phagocytosis. Mean ± SE values of Mercaptoethanol Sensitive Antibodies were calculated at 3rd, 6th, 9th and 12th day post immunization. Highest value was observed in Cornish (3.74±0.30) whereas lowest values were obtained in Kadaknath (1.00±0.25). Results showed that the higher IgM antibody were produced in exotic breeds as compared to indigenous breed and attained its peak at 6th day post immunization. Indigenous breed attained its peak at 9th day post immunization. Kundu et al. (1999b) [15] also reported the similar results. Natural IgM antibodies were present in all breeds under study and significant variation to Mercaptoethanol Sensitive response among various breeds on different day post sheep red blood cell immunization was observed.

Response to Phytohaemagglutinin (PHA-P)

In-vivo cell mediate immune response to Mitogen, Phytohaemagglutinin (PHA-P) was used as an indicator of general cellular immune responsiveness. The response to Phytohaemagglutinin and Foot Pad Index (FPI) obtained are presented in Table 4. After Phytohaemagglutinin inoculation the foot web thickness was highest in Kadaknath followed by Cornish and Australorp. The response, calculated as difference between increase in foot web index calculated by phosphate buffer saline and Phytohaemagglutinin response, was highest in Kadaknath (0.57±0.09) followed by Cornish (0.50±0.10) and Australorp (0.40±0.04). Pathak et al., (2017) [12] found similar response (0.43±0.05) in Kadaknath breed of chicken indicated that indigenous Kadaknath breed is the superior breed in producing cell mediated immunity. Thus, it is economically more feasible to rear Kadaknath for the backyard poultry farming as it will naturally reduce the inputs in health care. The response obtained after inoculation of Phytohaemagglutinin was significantly higher (P<0.05) in Kadaknath whereas values of Cornish and Australorp did not differ significantly. The comparison of different breeds for in-vivo cell mediate immune responsiveness to Phytohaemagglutinin, calculated by Foot Pad Index showed that the exotic and indigenous breed did not differ significantly (P<0.05). Similarly, Haunshi and Sharma (2002) [16] also reported non-significant effect of breed on general immunocompetence in four pure breeds and their selective crosses.

Table 4: Mean±SE value for response to Phytohaemagglutinin (PHA-P) in different breeds

| Traits                        | Exotic Breeds | Indigenous Breed |
|-------------------------------|---------------|------------------|
|                               | Australorp  | Cornish | Kadaknath  | Australorp  | Cornish | Kadaknath  |
|                               | Mean± S.E.  | Mean± S.E. | Mean± S.E. | Mean± S.E.  | Mean± S.E. | Mean± S.E. |
| Phosphate Buffer Saline       | 0.96b±0.09  | 1.03b±0.13 | 1.59a±0.18 | 0.96b±0.09  | 1.03b±0.13 | 1.59a±0.18 |
| Phytohaemagglutinin           | 1.37b±0.11  | 1.38b±0.15 | 2.06a±0.19 | 1.37b±0.11  | 1.38b±0.15 | 2.06a±0.19 |
| Foot Pad Index                | 0.40a±0.04  | 0.50±0.10 | 0.57±0.09  | 0.40a±0.04  | 0.50±0.10 | 0.57±0.09  |

a, b Means in the same row with different superscripts letters (a, b) were significantly different at (P<0.05)

Conclusion

Breed had significant (P<0.05) effect on immune responsive traits. Among exotic and indigenous breed, Kadaknath have excelled over Australorp and Cornish for generation of humoral immune response and for generation of cell mediate immune response. The results of the study revealed that indigenous breed were superior to exotic breeds in antibody production and disease resistance. We therefore advocate that it is more advantageous than exotic breeds to rear indigenous chicken breeds like Kadaknath as backyard poultry farming.

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Ethical approval

Prior permission from Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA) was taken for slaughtering of the birds and collection of blood samples under sterile condition to carry out the current research work.

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