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EFFECT OF IMMUNE RESPONSE TO SRBC ANTIGEN AND SEX ON IMMUNOGLOBULINS CONCENTRATIN AND LYMPHOID ORGANS WEIGHT IN CHICKENS

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ABSTRACT: *A total number of 320 birds of Norfa strain from both males and females were used in the present experiment. At 20-wk of age, the primary antibody (Ab) titers for sheep red blood cells (SRBC) were determined for each individual at 7-d post-immunization. Birds were divided into three, high, low and control, antibody titers groups with 20 males and 20 females of each group, in order to study the effect of Ab-titers and sex on immunoglobulins (IgG, IgM and IgA) concentration and lymphoid organs weight in Norfa chickens. The main results obtained can be summarized as follows:*

1- *The high immune response chickens had significantly the highest level (27.16) and the low immune response chickens had the lowest level (2.46) of primary Ab-titers, while the control chickens occupied intermediate level (7.44).*
2- *The immune response to SRBC had positive association with WBC counts, leukocyte (%), monocytes (%) and immunoglobulins (IgG, IgM and IgA) concentrations.*
3- *Males had significantly higher WBC counts and immunoglobulins (IgG, IgM and IgA) concentrations than females.*
4- *The IgM had the lowest concentration, where IgG concentration was predominated in absolute amount over other serum immunoglobulins in chickens.*
5- *High immune response chickens had heavier primary lymphoid organs weight than low immune response chickens. The weight values were 1.14 vs 0.28 g for bursa of Fabricius and 4.44 vs 3.36 g for thymus, respectively.*
6- *Control chickens had heavier spleen weight (1.64 g), than high (1.54 g) and low (1.06) immune response chickens, which explained unassociation of spleen weight with the immune response.*
7- *The present results concluded that high immune response chickens produced higher immunoglobulins (IgG, IgM, IgA) concentration. Also, heavy primary lymphoid organs weight produced higher level of antibody titers.*

Key words: *Chickens: immune response, immunoglobulins, primary lymphoid organs.*

INTRODUCTION

The primary antibody response to SRBC antigen revealed differences between two lines of chickens that had been selected for either high (H) or low (L) antibody response to SRBC (Gebriel, 1990 and Parmentier *et al.,* 1994). They concluded that the selected high immune response line had the highest means of antibody titers, while the low immune response line had the lowest means of antibody titers. Also, the divergent selection for high (H) and low (L) antibody response to SRBC in Norfa and WL chickens resulted in highly significant differences among lines. The high antibody response line harvested the highest antibody level, whereas the low line had the lowest antibody level over three generations (Abou-Elewa, 2004 and 2010).

On the other hand, Kundu *et al*. (1999) observed that males tended to have higher antibody titers than females for antibody response to SRBC antigen. But, contrary to the observation of Yang *et al*. (2000), who found that both sexes (male and female) responded antibody titers similarly to SRBC antigen. The differences between sexes were not statistically different. However, there are powerful initial responses to divergent selection for antibody response to SRBC antigen in chickens. Males of selected high line significantly had higher

antibody titers than females over three generations (Abou-Elewa, 2004 and 2010).

However, the number of WBC varied greatly due to the effect of antibody response (Brake and Brake, 1982). Also El-Fiky (2007) showed that the high immune response rabbits (HR) achieved superior values of white blood cells and their differentiations counted than the low immune response rabbits of both NZW and Cal parental rabbits. In additions, Gebriel *et al*. (2010) studied the WBC counts in control group in Norfa chickens. They found that the counts of WBC ranged from 21.34 to 39.13 x $10^3/mm^3$ with total average of 29.89 x $10^3/mm^3$. Recently, Khedr (2011) studied the interaction effect of primary antibody response to SRBC or BSA antigens on some blood constituents in Norfa chickens. She found that the high immune response chickens either to SRBC or BSA antigens had significantly the highest WBC counts as compared to both control and low immune response chickens.

Also, Eid (2010) found that the males had significantly higher counts of WBC than females in broiler chickens as affected by antibody titers against SRBC antigen. Recently, Khedr (2011) studied the interaction effect of sex and different levels of primary antibody response on some blood constituents in Norfa chickens. She found that males had significantly higher WBC than females with counts of 60.564 vs. 51.135 x $10^3/mm^3$ for males and females, respectively.

In addition, the H/L ratio is a recognized as a measure of stress in birds that has become a valuable tool in stress research specially when combined the convenience and repeatability of automated blood cell (Al-Murrani *et al*., 1997). Moreover, the H/L ratio has been suggested as selection criteria for general stress resistance in broiler chickens. The broiler line was a mixed population with only 10% males, and the males population had significantly higher H/L ratios as compared with females, suggesting that the addition stress of heavy body weight in males accounted for the increase in H/L ratio.

On the other hand, Martin *et al*. (1989) measured the kinetics of IgG and IgM in primary and secondary immune response in high and low immune response chickens. They found that the IgM and IgG were higher in high immune response than in low immune response chickens. Li *et al*. (2001) in turkey found that the F-line had a higher antibody response to SRBC and higher serum IgM concentration than the low immune response RBC2-line, the statistical differences were significant. Recently, Eid (2010) found that females of broiler chickens had higher concentration of IgG than males, but, the statistical differences between males and females were not significant.

However, the bursa of Fabricius is a key of lymphoid organs, that is responsible for the development and maturation of B-lymphocytes, and the humoral antibody response is dependent on this central organ. A high antibody response to SRBC has been associated with a larger bursa size in Whit Leghorn chickens strains (Zhang *et al*., 2006 and Cheema *et al*., 2007).

MATERIALS AND METHODS

The present study was carried out at the Poultry Research Farm, Department of Poultry Production, Faculty of Agriculture, Minufiya University, Shibin El-Kom, Egypt. The experiment was extended from Nov. 2008 to Oct. 2009, in order to investigate the effect of immune response to SRBC antigen and sex on immunoglobulins IgG, IgM and IgA concentration and lymphoid organs weight in chickens.

Chicken stock:

Norfa strain was used in the present study as a synthetic local strain of chickens. It was developed at the Poultry Research Farm, Department of Poultry Production, Faculty of Agriculture, Minufiya University, Shibin El-Kom, Egypt (Abdou, 1996).

Management procedures:

A total of 500 fertile eggs were collected from control line (Abou-Elewa, 2010) and moved to hatching room one night before incubation. The fertile eggs were then set in full-automatic force draft incubator. At 18

days of incubation, the eggs were transferred to hatching compartment. At hatching, all chicks were wing banded and pedigreed. Chicks were brooded and reared in batteries. They are fed a starter diet containing 18.05% crude protein from hatch till 8th week of age, and from 9th to 16th week of age, chickens were fed growing diet containing 14.01% crude protein. Then, pullets were fed a layer ration containing 17.46% crude protein. Cockerels were separated from pullets in brooding house at 8th week of age. At 14th week, cockerels were moved to individual cages in cocks house, while pullets were moved to individual cages in laying house at 16th week of age.

Experimental design and treatments:

A total of 320 individuals of Norfa chickens from both males and females were used in the present experiment as a base stock. At 20 weeks of age, the primary antibody response was determined for each individual at 7-day post-immunization. Chickens were divided into three groups based on the primary antibody titers against SRBC antigen 7-day post-immunization, as follows:

1- Control group (CR):

Chickens of control group were taken at random from the base stock (320 individuals). Control group contained 40 chickens from both sexes (20 males and 20 females).

2- High immune response group (HR):

The highest 20 males and the highest 20 females in the primary antibody titers were taken from the base stock to form the high antibody response group.

3- Low immune response group (LR):

The lowest 20 males and the lowest 20 females in the primary antibody titers were taken from the base stock to form the low antibody response group.

Determination of antibody response:

The primary antibody titers to SRBCs were determined for all individuals (320 individuals) at 20 weeks of age according to the method of Siegle and Gross (1980).

Counting of white blood cells (WBCs)

Serum sample from each chicken was collected and immediately examined for total leukocyte cells counts (LC) by using white blood pipette (Schalm, 1965 and Campbell, 1988), which monitored to count by using photomicroscope provide with a monitor screen and a counter.

Differential leukocyte cells counting:

Differential white blood cells counts provide information on the different white blood cells present in circulating blood. The leukocytes divided into agranules cells (as Lymphocytes and Monocytes), and granulates cells (Eosinophils, Neutrophils and Basophils). Differential leukocytes were counted according to Campbell (1998).

Determination of immunoglobulins IgM, IgG and IgA:

The concentration of the IgM, IgG and IgA wee determined by a single radial immunodiffusion technique (Mancini *et al.*, 1965).

Determination of relative lymphoid organs:

At 36 weeks of age, 10 females of chickens were taken at random from each group of Norfa chickens. Each bird was weighed and slaughtered. The bursa of Fabricius, spleen and thymus (all lobes) were cutting and weighed to the nearest milligram.

Studied traits:

The following traits were studied during the experimental period:

1.Primary antibody titers to SRBC: The primary antibody response was determined for each individual at 7 days post-immunization. The antibody response was expressed as antibody titers of log 2 of the reciprocal of the last serum dilution showing haemagglutinin.

2. White blood cells count: White blood cells (total leukocytes counts) were determined and expressed as LC (10^3 x cm^3).

3.Differential leukocytes percentages: The percentages of lymphocyte and monocyte counts, as agranules leukocytes, in addition to eosinophils, nutrophils and basophils, as granules leukocytes were determined and expressed as percentages of total leukocytes counts.

4.Determination of immunoglobulins (IgM, IgG and IgA): The immunoglobulins IgM, IgG and IgA were determined and expressed as (mg/dl).

5. Lymphoid organs weight and percentages: At 36 weeks of age, the birds were weighed and slaughtered. The bursa of Fabricius, thymus, and spleen were cutting and weighed to the nearest milligram. The percentage of lymphoid organs weight to mature body weight were calculated.

Statistical analysis:

Data were subjected to analysis of variance with antibody response and sex effects using the General Linear Model procedure of SAS user's Guide, (SAS, 2001). Duncan's multiple range tests was used for the multiple comparisons of means (Duncan, 1955). Also, all percentage data were converted to the corresponding arcsine prior statistical analysis (SAS, 2001). The statistical model used in the present study was:

$Y_{ijk} = \mu + \alpha_1 + \beta_j + (\alpha\beta)_{ij} + e_{ijk}$

Also the lymphoid organs weight were analyzed using the fowling model :

$Yij = \mu + \alpha i + eij$

Where:

Y_{ijk} = The observation of the ijk^{th}.

μ = The common mean.

α_i = The fixed effect of the i^{th} antibody response.

β_j = The fixed effect of the j^{th} sex.

$(\alpha\beta)_{ij}$ = The interaction between i^{th} antibody response and j^{th} sex.

e_{ijk} = Random error components assumed to be normally distributed.

RESULTS AND DISCUSSION

Antibody production:

Least square means (LSM $\pm$ S.E) of primary antibody titers at 7 days post-immunization, as affected by both immune response to SRBC antigen and sex in Norfa chickens are given in Table (1). The present results showed that the high immune response chickens had the highest value of antibody titers, while the low immune response chickens had the lowest value of antibody titers. The control chickens were in between. The values were 27.16, 2.46 and 7.44 for high, low and control groups of Norfa chickens. The statistical differences among immune response groups were highly ($P \leq 0.01$) significant.

Concerning the effect of sex on antibody production, the present results showed that females had higher primary antibody titers to SRBC antigen at 7-day post-immunization than males within each group of immune response chickens. But, the statistical differences between females and males were not significant. Means of antibody titers were 12.80 and 11.87 for females and males, respectively (Table 1).

The present results are in agreement with the results reported by Siegel and Gross (1980), Parmentier *et al.* (1994) and Abou-Elewa (2004 and 2010). They concluded that the high immune response chickens group for SRBC antigen had the highest antibody titers, and the low immune response chickens group had the lowest antibody titers, where the control group had intermediate value.

Table (1): Effect of both immune response and sex on antibody titers in Norfa chickens.

Immune response	Sex	No of chickens	Ab. Titers (LS M ± S.E.)	% Change of control
High response	M	20	25.96±2.43	372.98
	F	20	28.37±2.37	358.20
	M + F	20	27.16[a]±1.68	365.05
Low response	M	20	2.21±0.31	27.90
	F	20	2.70±0.46	29.74
	M + F	40	2.46[c]±0.27	28.76
Control	M	20	6.96±0.55	100.00
	F	20	7.92±0.52	100.00
	M + F	40	7.44[b]±0.38	100.00
Total average	M	60	11.87±1.63	170.55
	F	60	12.80±1.69	161.62
	M + F	120	12.35±1.65	165.99

a, b, c "Means with different letters are significantly different (P ≤ 0.05)".

On the other hand, Kundu *et al*. (1999) observed that males tended to have higher antibody titers than females for antibody response to SRBC antigen. But contrary to the observation of Yang *et al*. (2000), who found that both sexes (males and females) responded antibody titers similarly to SRBC antigen. The differences between sexes were not statistically different.

White blood cells (Leukocytes) counts:

The results in Table (2) explained that the high immune response chickens had higher counts of WBC than low immune response and control chickens. The counts were 35.69, 20.99 and 28.49 x $10^3/cm^3$ for high, low and control immune response chickens, respectively. The statistical differences among immune response groups of chickens were highly (P ≤ 0.01) significant.

The preset results are similar to the results reported by Brake and Brake (1982), El-Fiky (2007), Eid (2010) and Gebriel *et al*. (2010). They reported that the counts of WBC varied greatly due to the effect of antibody response. The high immune response chickens had higher counts of WBC as compared to the low immune response to SRBC and control chickens. Recently, Khedr (2011) found that the high immune response chickens either to SRBC or BSA had significantly the highest WBC counts as compared to both control and low immune response chickens.

Concerning the effect of sex on WBC counts in Norfa chickens (Table 2). The present results explained that males had significantly higher counts of WBC than females of Norfa chickens. The counts of WBC were 31.17 and 25.62 x $10^3/cm^3$ for adult males and females, respectively. The statistical differences between males and females were significant (P≤0.05). Similar results were reported by Eid (2010) and Khedr (2011). They found that males had significantly higher counts of WBC than females in chickens.

Table (2): Effect of both immune response and sex on white blood cells (WBC) in Norfa chickens.

Immune response	Sex	No of chickens	WBC (10^3/cm^3) (LS M ± S.E.)	% Change of control
High response	M	20	37.44±1.96	115.09
	F	20	33.95±1.84	138.85
	M + F	20	35.69[a]±1.36	125.27
Low response	M	20	23.53±1.31	72.33
	F	20	18.45±1.06	75.46
	M + F	40	20.99[c]±0.93	73.67
Control	M	20	32.53±1.40	100.00
	F	20	24.54±1.24	100.00
	M + F	40	28.49[b]±5.32	100.00
Total average	M	60	31.17±1.19	95.82
	F	60	25.62±1.12	104.79
	M + F	120	28.39±1.03	99.65

a, b, c "Means with different letters are significantly different ($P \leq 0.05$)".

Differential leukocytes percentages:

Data in Table (3) explained that the differential leukocytes percentages varied greatly due to the effect of antibody response to SRBC antigen. The high antibody response group of chickens had higher percentages of most different types of white blood cells as compared to the low immune response and control groups of chickens. The values in high immune response chickens were 59.83% lymphocytes, 27.36% heterophils, 3.66% eosinophils, 0.69% basophils, and 8.46% monocytes. The statistical differences among immune response groups of chickens were significant ($P \leq 0.05$). Similar results were reported by El-Fiky (2007) who showed that the high immune response rabbits achieved superior values of white blood cells and their differentiations counted than the low immune response rabbits.

Concerning the effect of sex on differential leukocytes percentages in Norfa chickens (Table 3). The present data explained that males had higher percentages of differential leukocytes than females. But, the statistical differences were not significant. The differential leukocytes percentages in males include 57.45% lymphocites, 13.82% heterophils, 4.08% eosinophils, 0.79% basophils, and 7.41% monocytes, where these percentages in females were 56.7%, 30.76%, 3.70%, 0.77% and 5.93% in the same order (Table 3).

In this respect, Brake and Brake (1982) found that the average number of WBC was 35.0 x 10^6/mm^3 for females of RIR chickens, which include 58.1% lymphocytes, 35.1% heterophils, 1.2% eosinophils, 3.1% basophils, and 2.5% monocytes. They concluded that males had higher WBC counts than females of chickens. Also, the present results explained that the (H/L) ratio were 0.46 for high immune response, 0.66 for low immune response and 0.54 for control chickens. The data cleared that the high immune response chickens had the lowest H/L ratio, where, the low immune response had the highest H/L ratio and the H/L ratio for control chickens was in between (Table 3).

Table (3): Effect of both immune response and sex on differential leukocytes percentages in Norfa chickens.

Trait	Sex	(LSM±S.E)			Total average
		HR	LR	Control	
Lymphocytes (L)	M	60.17±1.15	53.42±0.61	58.75±1.09	57.45±0.65
	F	59.50±1.20	53.92±1.13	56.67±0.79	56.70±0.81
	M + F	59.83^{a}±0.82	53.67^{c}±0.63	57.71^{b}±0.69	57.08±0.64
Heterophils (H)	M	27.92±0.90	35.11±0.64	32.42±1.02	31.82±0.62
	F	26.80±1.16	35.81±1.49	29.67±0.77	30.76±0.59
	M + F	27.36^{c}±0.89	35.46^{a}±0.87	31.04^{b}±0.68	31.29±0.66
Eosinophiles (E)	M	3.82±0.28	4.67±0.21	3.75±0.35	4.08±0.23
	F	3.50±0.31	3.93±0.71	3.67±0.43	3.70±0.35
	M + F	3.66^{c}±0.61	4.30^{a}±0.41	3.71^{b}±0.27	3.89±0.29
Basophiles (B)	M	0.67±0.18	0.88±0.42	0.81±0.72	0.79±0.29
	F	0.71±0.24	0.67±0.23	0.92±0.26	0.77±0.20
	M + F	0.69^{c}±0.15	0.78^{b}±0.24	0.87^{a}±0.16	0.78±0.24
Monocytes (M)	M	10.42±0.38	5.92±0.39	5.89±0.28	7.41±0.31
	F	6.49±0.54	5.67±0.71	5.63±0.31	5.93±0.38
	M + F	8.46^{a}±0.52	5.79^{b}±0.41	5.76^{b}±0.27	6.67±0.43
H/L ratio	M	0.41±0.01	0.66±0.02	0.57±0.01	0.54±0.01
	F	0.50±0.01	0.66±0.02	0.51±0.01	0.56±0.01
	M + F	0.46^{c}±0.01	0.66^{a}±0.02	0.54^{b}±0.01	0.55±0.01

a, b, c "Means with different letters are significantly different ($P \leq 0.05$)".

Immunoglobulins (IgG, IgM and IgA):

Data in Table (4) cleared that the high immune response group of chickens against SRBC had the highest values of IgG, IgM and IgA, where, the low immune response group of chickens had the lowest values and the control group was in between. The statistical differences among groups of chickens for the values of IgG, IgM and IgA were highly ($P \leq 0.01$) significant.

Least square means of IgG anti-SRBC antibody titers were 1427.36, 994.06 and 1084.19 mg/dl for high immune response, low immune response and control groups of chickens, respectively. Where, the values of IgM anti- SRBC antibody titers were 211.21, 88.89 and 116.78 mg/dl, in the same order. The IgA anti-SRBC antibody titers were 227.87, 143.56 and 186.51 mg/dl, respectively. The present results explained that concentration of IgM was the lowest, where the IgG concentration was predominated in absolute amounts over other immunoglbulins in Norfa chickens.

Similar results were reported by Martin *et al.* (1989). They measured the kinetics of IgG and IgM in primary and secondary immune response chickens. They found that the IgM and IgG were higher in high immune response the low immune responses chickens.

Table (4): Effect of both immune response and sex on immunoglobulins (IgG, IgM and IgA) in Norfa chickens.

Immunoglobulins	Sex	(LSM±S.E)			Total average
		HR	LR	Control	
IgG (mg/dl)	M	1221.32±145.72	988.34±37.76	1058.82±128.11	1089.49±119.32
	F	1633.40±113.03	999.78±37.58	1109.57±116.06	1247.58±123.21
	M + F	1427.36^{a}±109.98	994.06^{c}±36.67	1084.19^{b}±101.31	1168.53±121.19
IgM (mg/dl)	M	238.52±26.13	95.32±11.13	112.10±17.25	148.65±15.46
	F	183.90±12.86	82.46±10.19	121.46±19.51	129.27±14.61
	M + F	211.21^{a}±11.26	88.89^{c}±10.01	116.78^{b}±15.13	138±12.69
IgA (g/dl)	M	252.66±31.94	161.20±18.03	203.28±21.51	205.71±18.21
	F	203.08±28.15	125.92±11.68	169.74±18.11	166.25±19.33
	M + F	227.87^{a}±23.19	143.56^{c}±10.19	186.51^{b}±17.13	185.98±16.69

a, b, c "Means with different letters in each trait are significantly different ($P \leq 0.01$)".

Concerning the effect of sex on the concentrations of immunoglobulins (Table 4). The results explained that the males had higher concentration of IgM than females (148.65 vs. 129.27 mg/dl). Also, males had higher IgA than females (205.71 vs. 166.25 mg/dl), respectively. But, females had higher concentration of IgG than males (1247.58 vs. 1089.49). The statistical differences between sexes in the concentrations of immunoglobulins (IgG, IgM and IgA) were significant (Table 3). The present results agree with the results reported by Eid, (2010) who found that females had higher concentration of IgG than males, but the statistical differences between males and females were not significant.

Lymphoid organs weight:

Data given in Table (5) showed the LSM ± S.E of both immune response and sex effects on the lymphoid organs weight in Norfa chickens. The results explained that high immune response chickens had heavier lymphoid organs weight than the low immune response chickens. The values were 1.14 vs 0.28 (g) for bursa of Fabricius weight, 4.44 vs. 3.36 (g) for thymus weight and 1.54 vs. 1.06 g for spleen weight, respectively. The lymphoid organs weights in control chickens were in between. The statistical differences among chickens group were highly ($P \leq 0.01$) significant.

In addition, the high immune response chickens had higher percentages of live body weight at maturity (36-wk) than low immune response chickens for bursa of Fabricius (0.10 vs. 0.03%) and thymus (0.38 vs. 0.27%), respectively. While, control chickens had higher percentage than low immune response chickens for spleen (0.14 vs. 0.09%, respectively. The results cleared that lymphoid organs weights are easily measured and reflect the ability of body to provide lymphoid cells during an immune response. The spleen and bursa are the important lymphoid organs involved in the development and differentiation of T or B-lymphocytes.

However, the bursa of Fabricius is a key of lymphoid organs, that is responsible for the development and maturation of B-lymphocytes, and the humoral antibody response is dependent on this central organ. A high antibody response to SRBC has been associated with a larger bursa size in Norfa chickens. Similar findings were reported by Zhang *et al.* (2006) and Cheema *et al.* (2007) in White Leghorn chickens.

Table (5): Effect of both immune response and sex on lymphoid organs weight in Norfa chickens females.

Immune response	Determination	(LSM±S.E)		
		Bursa	Thymus	Spleen
High response	Weight (g)	1.14^{a}±0.11	4.44^{a}±0.38	1.54^{a}±0.12
	% of B.wt	0.10±0.00	0.38±0.03	0.13±0.01
Low response	Weight (g)	0.28^{c}±0.02	3.36^{c}±0.19	1.06^{b}±0.11
	% of B.wt	0.03±0.00	0.27±0.02	0.09±0.00
Control	Weight (g)	0.60^{b}±0.01	3.56^{b}±0.27	1.64^{a}±0.17
	% of B.wt	0.05±0.00	0.30±0.03	0.14±0.01

a, b, c "Means with different letters in each trait are significantly different ($P \leq 0.05$)".

Regarding to the immune organs weight and percentage. The control chickens had significantly heavier spleen weight and percentage as compared to high or low immune response chickens. These results agree with the finding reported recently by Eid, (2010) in broiler chickens.

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تأثير الإستجابة للمناعة للمستضد SRBC والجنس على تركيز الجلوبيولينات المناعية ووزن الغدد الليمفاوية في الدجاج

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الملخص العربى:

استخدم قطيع أساسى مكون من ٣٢٠ طائر من دجاج النورفا من كل من الذكور والإناث في هذه الدراسة. تم تقدير الاستجابة الأولية للمستضد كرات الدم الحمراء للأغنام (SRBC) لكل طائر بعد الحقن بمدة ٧ أيام عند عمر ٢٠ أسبوع. تم تقسيم الطيور إلى ثلاثة مجاميع (عالية المناعة، منخفضة المناعة، ومجموعة المقارنة) بكل مجموعة ٢٠ ديك، ٢٠ أنثى، بناء على مستوى الأستجابة للمناعة الأولية (Antibody titers)، بهدف دراسة تأثير مستوى الأجسام المضادة (Antibody titers) والجنس على تركيز الجلوبيولينات المناعية (IgG, IgM, IgA) ووزن الغدد الليمفاوية في دجاج النورفا، وكانت أهم النتائج المتحصل عليها كالآتي:

١- حصلت مجموعة الدجاج العالية الإستجابة للمناعة على أعلا مستوى معنوى (٢٧.١٦)، وحصلت مجموعة الدجاج المنخفضة الإستجابة للمناعة على أقل مستوى (٢.٤٦) تتر الأجسام المضادة (Antibody titers)، بينما حصلت مجموعة المقارنة على قيمة تتر متوسطة (٧.٤٤).

٢- وجدت علاقة موجبة بين الإستجابة للمناعة للمستضد SRBC مع عدد كرات الدم البيضاء (WBC)، والنسبة المئوية لخلايا(%) Leukocyte، والمونوسيت (%) Monocyte، وتركيز الجلوبيولينات المناعية (IgG, IgM, IgA).

٣- حصلت الذكور على عدد أعلا معنويا من كرات الدم البيضاء (WBC) وتركيز الجلوبيولينات المناعية (IgG, IgM, IgA) عن الإناث.

٤- كان تركيز الجلوبيولين المناعى IgM أقل تركيز، بينما كان تركيز الجلوبيولين المناعى (IgG) السائد على باقى الجلوبيولينات المناعية في سيرم الدم في الدجاج.

٥- حققت مجموعة الدجاج عالية الإستجابة للمناعة وزن أعلا من الغدد الليمفاوية الأولية عن مجموعة الدجاج المنخفضة الإستجابة للمناعة، حيث كانت قيمة وزن البورسا ١.١٤ مقابل ٠.٢٨ جرام، ووزن اللثيمس ٤.٤٤ مقابل ٣.٣٦ جرام، على التوالى.

٦- حققت مجموعة المقارنة وزن أثقل من الطحال (١.٦٤ جرام)، عن مجموعة الدجاج العالية (١.٥٤ جم) ومجموعة الدجاج المنخفضة (١.٠٦ جم) الاستجابة للمناعة، حيث توضح عدم وجود علاقة بين وزن الطحال والإستجابة للمناعة.

٧- تلخص هذه النتائج أن الإستجابة العالية للمناعة في الدجاج تنتج تركيز أعلا من الأمينوجلوبيولينات المناعية (IgG, IgM, IgA)، كما أن زيادة وزن الغدد الليمفاوية الأولية نتج مستوى أعلا من الأجسام المضادة (Antibody titers).