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APPLICATION OF IMMUNOGLOBULIN G (IGG) AS EARLY GENETIC MARKER TO IMPROVE SOME EGG PRODUCTION TRAITS IN CHICKEN

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ABSTRACT: The present study was carried out at the Department of Poultry and Fish Production, Faculty of Agriculture at Menoufia University, Shebin El-Kom. The aim of the present study was to apply the immunoglobulin G (IgG) as early genetic maker to improve some egg production traits in Norfa chickens. The IgG and Ab titers were determined in blood serum of each individual at 20 weeks of age. Pullets were divided into three groups, control, high and low groups, based on the IgG concentrations in blood serum.

The results were discussed and summarized as follows:

1- **The average concentrations of both IgG and Ab titers in the blood serum of Norfa chickens were 10.424 and 13.871 (mg/ml), respectively. The IgG makes up 75.1% of the total Ab titer concentrations. The IgG concentrations were 13.500, 7.576 and 10.195 (mg/ml) in high, low immune response and control groups, respectively.**

2- **Using high IgG concentrations (in high group) as early genetic marker improved, early age at sexual maturity with (10.0 days), light body weight at sexual maturity with (10.4%), light body weight at maturity with (9.0%) higher egg mass at 90 – days of laying with (25.4%) and higher egg mass at 42 weeks of age with (22.4%) as compared to control.**

3- **The IgG antibody classes can be used as good genetic marker to improve some egg production traits due to its positive correlations with most productive traits in chickens**

Key words: IgG, egg production traits, chickens.

INTRODUCTION

1. What is genetic markers in chickens:

A genetic marker is a gene or DNA sequence with a known location on a chromosome and associated with a particular gene or trait. It can be described, as a variation, which may arise due to mutation or alteration in the genomic loci that can be observed. A genetic marker may be a short DNA sequence, such as a sequence surrounding a single base-pair change (single nucleotide polymorphism, SNP), or a long one, like mini and micro satellite. (Weigend and Romanov, 2001).

2. Effects of IgG antibody concentrations on age at sexual maturity (Asm):

Age at first egg laid for each pullet was dramatically changed as the antibody concentrations to SRBC antigen changed. It was reported that the high antibody response to SRBC pullets reached sexual matucity earlier than the low antibody level pullets, The differences between high and low antibody response pullets were 13 d in the tenth generation (Siegel *et al*., (1982).

Similar results were reported by Martin *et al*., (1990). They found that the high immune response pullets reached

sexual maturity earlier than the low antibody line pullets. The differences between high and low antibody line pullets were 22 days in the 14th generation.

In addition, Abou-Elewa, (2004), studied the effect of antibody response to SRBC antigen on age at sexual maturity in both White Leghorn and Norfa strains of chickens. She found that the high immune response pullets reached sexual maturity earlier than the low or control pullets in all generations. The differences between the high and low pullets were 15 d in the first generation, 16 d in the second generation, and 23 d in the third generation in White Leghorn pullets. The corresponding values were 10, 14 and 17 d in Norfa pullets, respectively.

However, Kallio*et al*., (2006) reported that the earlier maturation pullets of chickens were achieved as an extension of enhanced growth during growing perid.

However, Gebriel*et al*., (2010) studied the genetic and phenotypic parameters of antibody response to SRBC in relation to some egg production traits in chickens. They found that the age at sexual maturity in selected line of Norfa chickens for high antibody to SRPC in the first generation was 161.3 ± 1.367 d. They also, reported that the magnitudes of heritability, genetic and phenotypic correlations estimates indicated good prospects of improving the age at sexual maturity in Norfa chickens through direct selection for high antibody response.

Recently, El-Mougy, (2018) studied the effect of IgG antibody concentrations on age at sexual maturity in two lecal improved strains of chickens. She found that high IgG antibody pullets reached sexual maturity significantly (P≤0.01) earlier than both control and low IgG antibody lines being 6.08 and 11.97 d in Silver Montazah chickens and 6.31 and 13.41 d in Sinai chickens, respectively.

3. Effect of IgG concentrations on body weight at sexual maturity (BWsm):

The effects of immune response to SRBC antigen and body weight at sexual maturity were studied by some investigators. Early reports by Siegle and Gross (1980) who selected chickens divergently for immune response against injected sheep red blood celss (SRBC) for three generations, They found that the low immune reponse line pullets were significantly heavier in body weight at sexual maturity than control and high immune response lines.

In addition, Martin *et al*., (1990) found that body weights in the low immune response line chickens were heavier than those in the high immune response line pullets at 24 weeks of age in pullets selected for antibody response against SRBC.

On the other hand, Gebriel (1991a&b) studied the genetic relationship of each of body weight at sexual maturity and antibody titers with the B-MHC in Fayoumi chickens. He found that there were positive significant coefficients (0.207 to 0.543) between SRBC antibody titers and body weight at sexual maturity.

Moreover, Parmentier *et al*., (1998) studied the effect of antibody concentrations on body weight at sexual maturity of chickens. They found that body weights of control and low antibody concentrations lines were significantly heavier than body weights of high antibody concentration birds at sexual maturity.

In addition, Abou–Elewa, (2004) studied the relation between antibody titers to SRBC and body weight at sexual maturity in White Leghorn chickens. She found that body weight at sexual maturity

averaged 1180.70, 1251.49 and 1335.19 g for high, control and low antibody titers lines, respectively. The chickens of the low antibody titers line was significantly (P≤0.01) heavier in body weight at sexual maturity than their high or control antibody titers lines being 11.58 and 6.27% in White Leghorn chickens, respectively.

Recently, El-Mougy, (2018) studied the effect of IgG antibody concentration on body weight at sexual matucity in two local improved strains of chickens. She reported that the pullets of low IgG antibody lines were significantly (P≤0.01) heavier body weight at sexual maturity than the high and control pullets being 3.22% and 1.79% in silver Montazah chickens, respectively. The Corresponding values in Sinai chickens were 7.64% and 4.87%, respectively.

4. Effect of IgG antibody concentrations on body weight at maturity (BW_m):

The effects of IgG antibody concentrations on body weight at maturity in laying hens were studied in chickens. Early studied by Maritn *et al*., (1990) and Parmentier *et al*., (1998) who reported that the high antibody line of chickens was significantly lower in body weight at matucity (38 wk of age) than the control and low antibody concentrations lines of chickens.

In addition, similar results were found by Abou–Elewa, (2004 and 2010). She reported that the low antibody concentration lines of White Leghorn layers were heavier in body wiehgt at maturity (36 wk of age) than both high IgG and control lines. The low IgG line had 14.2% and 4.4 heavier than both high IgG and control lines, respectively.

Moreover, Gebriel *et al*., (2010) found statistically significant (P≤0.05) differences in body weight at maturity between control and selected lines for high antibody response to SRBC antigen in Norfa chickens. The least square means of body weight at maturity were 1324.32 g and 1287.36 g. for control and selected line for high antibody in the first generation They also found that the direct selection for high antibody titers to SRBC antigen had a negative relationship between immune status of chickens and body weight at maturity (36 wk of age).

5. Effects of IgG antibody concentrations on egg production traits:

The effect of immunoglobulin (Ig) concentrations on egg production traits (EN, EW and EM) at 90-days of laying and 42 weeks of laying in chickens were studied by different investigators.

Early studied by Pitcovski *et al*., (1987) reported that the high immune response line of chickens had the highest egg number at 42 weeks of age, where the low concentrations of antibody titer had the lowest egg number at 90-days of laying and 42 weeks of age.

In addition, Li *et al*., (1998) studied the relation between the IgG concentrations and hen – day egg production in both single Comb White Leghorn (SCWL) and Rhode Island Red (RIR). They found that the percentage of hen- day egg production was approximately two times higher (P≤ 0.01) in the SCWL than in the RIR hens. They concluded that the concentrations of IgG is considered to be important factor for the efficient of egg production.

However, Abou-Elewa, (2004 and 2010) studied the effect of antibody response on some egg production traits in both White Leghorn and Norfa layers at 90-days of laying and 42-wk of age. She found that the high immune response line had the highest significant means of egg number, the smallest

significant means of egg weight and the largest significant means of egg mass in both White Leghorn and Norfa layers as compared to control and low immune response lines.

Recently, El-Mougy, (2018) studied the effect of IgY concentrations on egg production traits at 90-days of laying and 42-wk of age in chicken layers. She found that the high immune response lines had 19.43 – 21.69% eggs higher in egg number and 11.13- 13.04% (g) higher in egg mass at 42-wk of age in both Silver Montazah and Sinai strains of chickens as compared to the low immune response lines. The control line had intermediate values.

MATERIALS AND METHODS

The present study was carried out at the Department of poultry and fish production, Faculty of Agriculture, Shibin El-kom, Menoufia University, Egypt .The experiments were extended from NOV./ 2018 to Feb., 2020, in order to apply the immunoglobulin G (IgG) as early genetic marker to improve some egg production traits in chickens

1. Chickens stock:

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

2. Mating system and parents reproduction:

A total of 25 sires and 100 dams were used as parents for reproducing the next generation. The artificial insemination was used as a mating system for reproducing the chickens stock of the next generation. Each family contained one sire and four dams. Dams were assigned at random to each sire for reproducing the next generation.

Fertile eggs were collected two times a day and pedigreed according to their dams. Cracked, dirty, and misshapen eggs were removed. Then, eggs were stored in eggs storage room at 15-17 C^0 for 7 days, with 80% relative humidity.

For hatching, all fertile eggs were moved to the incubation room and left for at least 12-hours at room temperature. Then, all eggs were set with wide end up in the setting trays according to their dams and incubated in a forced draft incubator at 99.5^0 F (37.8˚C) with a relative humidity of 60.0% during the incubation period. On the day of hatching, chicks were wing banded, weighed and moved to brooding house.

3. Experimental stock managements:

Chicks identified according to their dams were weighed and moved from hatcher to brooding house. All chicks were brooded in floor brooder with wood shaving litter. The starting brooder temperature was 34˚C during the first week. Then, the brooder temperature was decreased gradually froom 2-3 ˚C every week to reach 22-24 ˚C at almost six weeks of age. The chicks were moved to rearing house at eight weeks of age.At 18-weeks of age, pullets were moved to individual cages in laying house, where the hens were kept until 42-weeks of age under 16-hours of light a day. While, the males were moved to individual cages in cock house.

All chicks were fed *adlibitume* diet, which contained 19.88% crude protein and 2889 Kcal ME/Kg diet, during both the brooding and rearing periods. Whereas, chickens were fed *adlibitum* diet which contained 17.51% crude protein and 2739 kcal ME/kg diet during production period until the end of experiment (NRC,1994).

4. Experimental design and treatments:

A total number of 115 individuals (85 females plus 30 males) of Norfa pullets were taken at random to be used in the present experiment. At 18-weeks of age, the pullets were housed individually in wire individual cages in laying house, where the hens were kept until the end of the experiment (42- weeks of age), where males were kept in cock house.

At 20-weeks of age, the immunoglobulin G (IgG) was determined in blood serum of each individual. Pullets were divided into three groups based on the IgG concentrations as follows:

4.1. Control group (CG):

Pullets of control group (CG) were taken at random from the stock. Control group contained 22 females and 7 males. No significant difference was found in IgG concentration

4.2. High immunoglobulin G (IgG) group (HG):

Pullets reached IgG concentrations in blood serum more than ($\bar{x}$ ± SE) were selected and considered as high immunoglobulin G (HG). The HG contained 25 females and 8 males.

4.3. Low immunoglobulin G (IgG) group (LG):

Pullets had IgG concentrations in blood serum lower than ($\bar{x}$ ± SE) were selected and considered as low group (IgG). The low group contained 25 females and 8 males.

5. Determination of immunoglobulin G (IgG) and Ab titers in pullets of chickens in all groups:

5.1 Preparation of SRBCs antigen:

The SRBCs were chosen as natural, non-specific, non- pathogenic and multi-determinant immunizing antigen to elicit the antibody response in the chickens (Kundu *et al*., 1999). The SRBCs were obtained in a heparin solution from 5 Ossimi sheep breed and washed three times in phosphate buffer saline (PBS, pH 7.2). After final wash, the packed SRBCs were brought to a 2.5% vo/vo solution in the PBS and used for immunization.

5.2. Antigen immunization:

The SRBCs were immunized using a slight modification in the method of Siegel and Gross (1980). In the primary immunization, at 20 weeks of age, each chicken received an intravenous inoculation via the branchial vein with 0.1 ml of 2.5% SRBCs suspension to induce the primary antibody response.

5.3. Blood samples collection and serum preparation:

At 20 – wk of age, about 2 ml of blood sample was collected individually in dry tube via the wing vein. The blood samples were centrifuged at 3000 rpm for 15 min. at 4°C. Serum was collected, placed individually in disposable tubes and frozen for subsequent laboratory determination (Siegel and Cross, 1980).

5.4. Determination of immunoglobulin G (IgG) and Ab titers concentrations:

The Immunoglobulin G (IgG) and Ab titer concentrations were determined individually in Lab. Top in Zagazig City, Sharkia Governorate, using mono Reagents, specific for IgG determination, by applying ELISA method according to Tip (2010). Both IgG and Ab titers concentrations were recorded as mg/ ml.

6. Studied traits:

The following traits were studied during the experimental period.

6.1. Determination of IgG and Ab titer concentrations:

The concentrations of IgG and Ab titer were determined individually in blood serum of chickens at 20 – wk of age, and recorded as mg/ ml.

6.2. Age at sexual maturity (A_{sm}):

Age at sexual maturity in days was recorded at first egg laid for each pullet, in selected and control groups, during the experimental period.

6.3. Body weight at sexual maturity (BWsm):

Individual body weight in grams was recorded at sexual maturity for pullets, in selected and control groups, during experimental period.

6.4. Egg number (EN):

Individual egg number for each layer was recorded as the number of eggs laid during the first 90 days of laying hen (EN 90d), as well as, during the first 42 weeks of age (EN 42 wk) in selected and control groups of Norfa layers during the experimental period.

6.5. Egg weight (EW):

Average egg weight of five eggs was measured during the first period of laying as an average weight of all eggs laid during the first 90 days of laying (EW 90 d), as well as, the average weight of five eggs laid at 38 weeks of age as an average weight of all eggs laid during 42 weeks of age (EW 42 wk) in selected and control groups of Norfa layers during the experimental periods.

6.6. Egg mass (EM):

Egg mass was calculated by multiplying the number of eggs per laying hen times the average egg weight in grams during the first 90 dyas of laying (EM 90 d), as well as, during the first 42 weeks of age (EM 42 wk) in selected and control groups of Norfa layers.

7. Statistical analysis:

Least square means and their standard errors ($\bar{x} \pm$ SE) for each studied traits were calculated for each group. Data obtained were statistically analyzed using SPSS (2019). Probability values ($p \leq 0.05$) and ($p \leq 0.01$) were considered for significant and highly significant, respectively.

All percentages data were converted to the corresponding arcsine prior statistical analysis as given by SAS (1988). Also, Duncan's multiple range test (DMRT) was used for the multiple conparisons of means (Duncan, 1955).

One way classification statistical fixed model was used for statistical analysis as the following:

$Y_{ij} = \mu + G_i + e_{ij}$

Where:

Y_{ij} **=The 1th observation of the individual over all means.**

μ**= The common mean.**

G_i **= The fixed effect of IgG response.**

e_{ij} **= The experimental error.**

RESULTS AND DISCUSSION

1. The concentrations of both IgG and antibody titer in bloodserum of chickens.

The concentrations of IgG (mg/ml) and Ab titer ($\bar{x} \pm$ SE) in blood serum of Norfa chickens are give in Table (1). The IgG concentrations were ranged from 5.66 to 17.27 with an average of 10.424 (mg/ml). The high immune response group (HG) had the highest concentration of IgG which averaged (13.500 mg/ml), whereas the low immune response group (LG) had the lowest concentration of IgG which averaged (7.576 mg/ml). The concentration of IgG in control group was in between (10.195 mg/ml). The statistical differences among groups of chickens were highly significant ($P \leq 0.01$).

Table (1): The IgG and Ab titer concentrations in blood serum of different groups in Norfa chickens.

Chicken groups	No.	Concentrations ($\bar{x}$ ± SE)		% IgG change	
		IgG mg/ml	Ab titer	Of control	Of Ab titer
Control	22	10.195± 0.24b	13.601± 0.240b	100.0	74.96
High IgG	25	13.500 ± 0.46a	17.901 ± 0.361a	132.4	75.40
Low IgG	25	7.576 ± 0.42c	10.111 ± 0.363c	74.3	74.93
Total average	72	10.424 ± 0.37	13.871 ± 0.371	102.2	75.10
p.value	-	0.01	0.01		

*** IgG = Immunoglobuling.**
a,b,c = Means in the same column bearing different superscripts are significantly different (P<0.01).

The percentages of change of IgG concentration as compared to control group (100%) were 132.4% and 74.3% for HG and LG. groups, respectively. In addition, the concentration of IgG antibody class in blood serum of layers makes up an average of 75.10% of the total antibody titers.

Concerning the concentration of Ab titer in blood serum of chickens, it ranged from 7.51 to 23.12 with an average of 13.871 (Table 1). The high antibody titer group had the highest concentration of Ab titer in blood serum of chickens, which recorded 17.901, whereas the low Ab titer group had the lowest concentration of Ab titer (10.111). The concentration of Ab titer in control group was intermediate (13.601). The statistical differences among groups of Ab titer chickens were highly ($P \leq 0.01$) significant.

The present results cleared that the divergent selection for high and low immune response, resulted in highly significant differences ($P \leq 0.01$) among groups. The high immune response group had the highest both IgG and Ab titer concentrations which averaged 13.500 mg/ml and 17.901, respectively. The control group occupied intermediate levels of IgG and Ab titer (10.195 mg/ml and 13.601, in the same order). Whereas the low group had the lowest levels of both. IgG and Ab titer (7.576 mg/ml and 10.111, respectively). Also, the IgG level makes up 75.1% of the total Ab titer concentrations in blood serum.

The present results are almost similar to the results reported by Carlander (2002). They found highly significant differences among lines of chicken in IgG concentration in blood serum of chickens. Also, Abou-Elewa (2004) found that the primary Ab titers were 9.10, 6.59 and 4.82 mg/ml for high, control and low immune response groups in White Leghorn chickens in the 3rd generation, respectively. The corresponding values in Norfa chickens were 9.30, 6.79 and 4.95 mg/mg, in the same order.

2. The relationship between IgG antibody concentrations and age at sexual maturity (days) in Norfa chickens.

The effects of control and selected groups of chickens for high (HG) and low (LG) IgG antibody concentration groups on age at sexual maturity (days) were given in Table (2). The results showed that the age at sexual maturity ranged from 144.0 to 188.0 days with an average of 172.51 days.

In addition, the high IgG antibody concentration group had significantly the earlier age at sexual maturity (161.36 days), whereas, the low IgG antibody concentration group had the latest age at sexual maturity (184.80 days). The control group was intermediate (171.36

days). The statistical differences among groups were highly (P≤0.01) significant.

Also, the percent change of high IgG antibody concentration group significantly had the lowest age at sexual maturity with 5.8% earlier than control and 11.6% earlier than the low IgG antibody group. The present results cleared that selection for high IgG antibody concentrations resulted in earlier age at sexual maturity with 10 days than control group and 23.44 days than low antibody group.

Early results by Siegle *et al*., (1982) who reported that age at first egg laid for each pullet was dramatically changed as the antibody concentrations to SRBC antigen changed. They found that the high antibody response to SRBC pullets reached sexual maturity earlier with 13 days than the low antibody response group in the 10th generation.

Similar results were reported by Martin *et al*., (1990). They found that the high antibody response pullets reached age at sexual maturity earlier than the low antibody line pullets. The differences between high and low antibody lines were 22 days in the 14th generation.

In addition, Abou-Elewa, (2004) found that the high antibody response to SRBC pullets reached age at sexual maturity earlier than low or control pullets in all generations. The differences between high and low pullets were 15 days in the first generation, 16 days in the second generation, and 23 days in the third generation in White Leghorn pullets. The corresponding values were 10, 14, and 17 days in Norfa Pullets, respectively.

Recently, El-Mougy, (2018) found that the high IgG antibody pullets reached sexual maturity significantly (P≤ 0.01) earlier than both control and low IgG antibody pullets, being 6.08 and 11.97 days in Silver Montazah pullets and 6.31 and 13.41 days in Sinai pullets, respectively.

3. The relationship between IgG antibody concentrations and body weight at sexual maturity (BWsm):

The effects of control and selected groups of chickens for high (HG) and low (LG) IgG antibody concentrations on body weight at sexual maturity (BWsm) are given in Table (3). The results showed that the body weight at sexual maturity ranged from (794.0 – 1196.0 g) with an average of (985.33 g).

In addition, the high IgG antibody concentration group had significantly the lightest body weight at sexual maturity (880.76 g), where, the low IgG antibody concentration group had the heaviest body weight at sexual maturity (1109.10 g). The control group was in between (983.50 g). The statistical differences among groups were highly (P≤0.01) significant.

Table (2): Effect of different groups for high (HG) and low (LG) IgG concentrations on age at sexual maturity (days) in Norfa chickens.

Chicken groups	No.	Age at sexual maturity (days)	Mean (days) $\bar{x} \pm SE$	% change of control
Control	22	166.0- 179.0	171.36± 0.91b	100.0
High IgG	25	144.0–164.0	161.36± 1.14a	94.2
Low IgG	25	179.0 – 188.0	184.80± 0.52c	107.8
Total average	72	144.0– 188.0	172.51± 1.27	100.6
p.value	-	-	0.01	-

a,b,c = Means in the same column bearing different superscripts are significantly different (P≤0.01).

Table (3): Effect of different levels of IgG on body weight at sexual maturity (g) in Norfa chickens.

Chicken groups	No.	BW_{sm} (g)	Mean (g) $\bar{x} \pm SE$	% change of control
Control	22	923.0- 1009.0	983.50± 6.04b	100.0
High IgG	25	794.0–923.0	880.76± 7.64a	89.6
Low IgG	25	996.0 – 1196.0	1109.12± 10.38c	112.8
Total average	72	794.0– 1196.0	985.33± 12.38	100.2
p.value	-	-	0.01	-

a,b,c = Means in the same column bearing different superscripts are significantly different (P≤0.01).

Moreover, the percent changes of high IgG antibody concentration group significantly had body weight at sexual maturity with 10.4% lighter than control and 23.2% lighter than the low IgG antibody group. The present results cleared that selection for high IgG antibody concentrations as genetic marker resulted in improvement of body weight at sexual maturity with 10.4% lighter than control group and 23.2% lighter than low antibody group.

The effects of immune response to SRBC antigen on body weight at sexual maturity were studied by some investigators (Siegle and Gross, 1980; Martin *et al*., 1990 and Parmentier*et al*., 1998). They selected pullets divergently for immune response against injected SRBC antigen for more than one generation. They found that body weight of control and low antibody concentrations lines were significantly heavier than body weight of high antibody concentration pullets at sexual maturity.

Similar results were reported by Abou–Elewa, (2004). She selected pullets for high and low antibody response to injected SRBC antigen in White Leghorn chickens. She reported that the low antibody titers line was significantly (P≤0.01) heavier in body weight at sexual maturity than their high or control antibody titers lines being 11.58% and 6.27% in White Leghorn pullets, respectively.

Recently, El-Mougy, (2018) studied the relationship between antibody response to SRBC and body weight at sexual maturity. She found that the pullets of low IgG antibody line were significantly (P≤0.01) heavier body weight at sexual maturity than high and control pullets being 3.22% and 1.79% in Silver Montazah pullets, respectively. The corresponding values in Sinai chickens were 7.64 and 4.87%, respectively.

4. The relationship between IgG antibody concentration and body weight at maturity (BW_m):

The effects of control and selected groups of chickens for high (HG) and low (LG) IgG antibody concentrations on body weight at maturity (36 wk) are shown in Table (4). The results showed that the body weight at maturity ranged from 960.0 to 1350.0 (g) with an average of 1135.98 (g).

In addition, the high IgG antibody concentration group had significantly the lightest body weight at maturity (1026.0 g), whereas, the low IgG antibody group had the heaviest body weight at maturity (1254.92 g). The body weight of the control group was in between (1127.04 g). The statistical differences among groups were highly (P≤0.01) significant.

Table (4): Effects of different groups for high (HG) and low (LG) IgG concentrations on body weight at maturity (g) in Norfa chickens.

Chicken groups	No.	BW_m (g)	Mean (g) $\bar{x} \pm SE$	% change of control
Control	22	1080.0- 1200.0	1127.04b	100.0
High IgG	25	960.0–1080.0	1026.00a	91.0
Low IgG	25	1209.0 – 1350.0	1254.92c	111.3
Total average	72	960.0– 1350.0	1135.98	100.7
P. value	-	-	0.01	-

a,b,c = Means in the same column bearing different superscripts are significantly different (P≤0.01).

Also, the percent changes of high IgG antibody concentration group had significantly body weight at maturity with 9.0% lighter than control and 20.3% lighter than low IgG antibody group (Table 4). The present results cleared that selection for high IgG antibody concentrations as genetic marker resulted in improvement of body weight at maturity with 9.0% lighter than control group and 20.3% lighter than low antibody group.

Early studies in this respect were carried out by Martin, *et al*., (1990) and Parmentier, *et al*., (1998). They reported that the high antibody line of chickens was significantly lower in body weight at maturity (38 weeks of age) than the control and low antibody concentrations of chickens.

Similar results were reported by Abou-Elewa, (2004). She found that the low antibody concentration lines of White Leghorn layers were heavier in body weight at maturity (36 weeks of age) than both high IgG and control lines. The low IgG line had 14.2% and 4.4% heavier than both high IgG and control lines, respectively.

In addition, Gebriel, *et al*., (2010) found statistically significant differences (P≤0.05) in body weight at maturity (36 wk of age) between control and selected lines for high antibody response to SRBC antigen in Norfa chickens. The least square means of body weight at maturity were 1324.32g and 1287.36g. for control and selected line for high antibody response in the first generation. They also reported that the direct selection for high antibody titers to SRBC antigen had a negative relationship between immune status of chickens and body weight at maturity.

5. The relationship between IgG antibody concentrations and egg production traits (EN, EW and EM) at 90 days of laying.

The effects of control and selected groups of chickens for high (HG) and low (LG) IgG antibody concentrations on egg production traits (EN, EW and EM) at 90 days of laying in Norfa chickens are given in Table (5). The results explained that the egg number was ranged from 28.00 to 60.24 eggs with total average of 45.34 eggs. Also, the egg weight was ranged from 41.10 to 41.86 (g) with an average of 41.51 (g). Where, the egg mass was ranged from 1150.80 to 2506.58 (g) with an average of 1885.16 (g) at 90 days of laying.

In addition, the high IgG antibody concentration group had significantly the highest mean of egg number (60.24 eggs) and the largest significant mean of egg

mass (2506.58g). The total average of egg weight was 41.51 (g). Where, the low IgG antibody concentration had the lowest significant mean of egg number (28.0 eggs), and the smallest significant mean of egg mass (1150.80g), with an egg weight average of 41.10 (g). The control group had in between values of egg number (47.77 eggs/ bird) and egg mass (1999.65g), with an egg weight average of 41.86 (g) at 90 days of laying.

Also, the statistical differences among groups in egg number and egg mass were highly significant (P≤ 0.01), where the statistical differences among groups in egg weight trait were not significant.Moreover, the percent change of high IgG antibody concentration group had significantly egg mass at 90 days of laying with 25.4% higher than control group and 67.8% higher than low IgG antibody group.

The present results cleared that selection for high IgG antibody concentrations as genetic marker improved of egg mass in Norfa layers with 25.4% higher than control group and 67.8% higher than low IgG antibody group at 90 days of laying.

The present results are in good agreement with the results reported by Pitcovski*et al*., (1987). They observed that greater egg number in the high immune response line than the low immune response line of chickens.

In addition, Abou-Elewa, (2004) studied the relation between antibody response and egg production traits. She reported that the high immune response line had the highest significant means of egg number, the smallest significant means of egg weight, and the largest significant means of egg mass as compared to control and low immune response lines at 90 days of laying in the third generation.

Recently, El-Mougy, (2018) studied the relation between IgG antibody concentrations and egg production traits of control and selected groups of two local strains of chickens. She reported that highly significant differences (P≤0.01) among groups for egg number, egg weight and egg mass in both Silver Montazah and Sinai strains of chickens. The high IgG antibody concentration group had the highest significant of egg number, the lowest significant means of egg weight and the largest significant means of egg mass as compared to the low IgG antibody concentration in both local strains of chickens at 90 days of laying.

Table (5): Effects of different groups for high (HG) and low (LG) IgG concentrations on egg production traits (EN, EW and EM) at 90 days of laying in Norfa chickens.

Chicken groups	No.	Egg number $(\overline{x} \pm SE)$	Egg weight $(\overline{x} \pm SE)$	Egg mass (g)	
				$(\overline{x} \pm SE)$	% change of control
Control	22	47.77± 1.19b	41.86 ± 0.68	1999.65 ± 58.8b	100.0
High group	25	60.24 ± 0.75a	41.61 ± 0.70	2506.58 ± 49.7a	125.4
Low group	25	28.00 ± 1.04 c	41.10 ± 0.58	1150.80 ± 45.2 c	57.6
Total aver	72	45.34 ± 1.70	41.51 ± 0.38	1885.16 ± 73.5	94.3
P. value	-	0.01	N.S	0.01	-

a,b,c = Means in the same column bearing different superscripts are significantly different (P≤0.01). N.S. = Not significant.

6. The relationship between IgG antibody concentrations and egg production traits (EN, EW and EM) at 42 weeks of age:

The effects of control and selected groups of chickens for high (HG) and low (LG) IgG antibody concentrations on egg production traits (EN, EW and EM) at 42 weeks of age in Norfa chickens are given in Table (6). The results showed that the egg number was ranged from 46.88 to 88.04 eggs/ bird with total average of 69.15 eggs/ bird at 42 weeks of age. The egg weight was ranged from 50.40 to 51.21 (g) with total average of 50.90 (g). Where, the egg mass was ranged from 2362.75 to 4508.53 (g) with total average of 3518.63 g/bird at 42-wk of age.

Also, the high IgG antibody concentration group had significantly the highest mean of egg number (88.04 eggs/bird) and the largest significant mean of egg mass 4508.53 g/ bird. The total average of egg weight was 51.21 (g). Where, the low IgG antibody concentration group had the lowest significant mean of egg number (46.88 g/bird) and the smallest significant mean of egg mass (2362.75 g/ bird) with egg weight averaged (50.40g). The control group had in between values of egg number (72.12 eggs/ bird) and egg mass (3684.61 g/ bird) with egg weight averaged (51.09g) at 42 weeks of age.

In addition, the statistical differences among groups in both egg number and egg mass were highly significant (P≤0.01), where the statistical differences among groups in egg weight trait were not significant. Although, the percent change of high IgG antibody concentration group had significantly egg mass at 42 weeks of age with 22.4% higher than control group and 68.5% higher than low IgG antibody concentration group at 42 weeks of age.

In this respect, Pitcovski*et al*., (1987) reported that the high immune response line of chickens had the highest egg number at 42 weeks of age, where, the low immune response concentration had the lowest value of egg number at 42 weeks of age.

Also, Li, *et al*., (1998) studied the relation between the IgG concentrations and hen – day egg production in both Single Comb White Leghorn (SCWL) and Rhode Island Red (RIR). They reported that the percentage of hen – day egg production was approximately two times higher (P≤ 0.01) in the SCWL than in RIR hens. They concluded that the concentration of IgG is considered to be Important factor for the efficient of egg production.

In addition, Abou-Elewa, (2004) studied the effect of antibody response to SRBC antigen and some egg production traits in both White Leghorn (WL) and Norfa chickens at 42 weeks of age. She found that the high immune response line had the highest significant means of egg number, the smallest significant means of egg weight and the largest significant means of egg mass in both White Leghorn and Norfa layers as compared to control and low immune response lines.

Recently, El-Mougy, (2018) studied the effect of IgY concentrations on egg production traits (EN, EW and EM) at 42-wk of age in chicken layers. She found that the high IgY antibody concentration lines had 19.43 to 21.69% eggs higher in egg number and 11.13 to 13.04% higher in egg mass at 42-wk of age in both Silver Montazah and Sinai strains of chickens, respectively, as compared to the low IgY antibody concentration lines. The control line had intermediate values.

Table (6): Effects of different groups for high (HG) and low (LG) IgG concentrations on egg production traits (EN, EW and EM) at 42-weeks of age in Norfa chickens.

Chicken groups	No.	Egg number $(\bar{x} \pm SE)$	Egg weight (g) $(\bar{x} \pm SE)$	Egg mass (g)	
				$(\bar{x} \pm SE)$	% change of control
Control	22	72.12± 1.27	51.09 ± 0.57	3684.61 ± 626.1	100.0
High group	25	88.04 ± 1.26	51.21 ± 0.75	4508.53 ± 602.3	122.4
Low group	25	46.88 ± 1.56	50.40 ± 0.55	2362.75 ± 351.1	64.1
Total average	72	69.15 ± 2.21	50.90 ± 0.36	3518.63 ± 875.6	95.4
P. value	-	0.01	N.S	0.01	-

a,b,c = Means in the same column bearing different superscripts are significantly different (P≤0.01). N.S. = Not significant.

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تطبيق أميونوجلوبيولين (IgG) G كدليل وراثي مبكر لتحسين بعض صفات إنتاج البيض في الدجاج

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الملخص العربى

أجريت هذه الدراسة بقسم إنتاج الدواجن والأسماك، كلية الزراعة بشبين الكوم، جامعة المنوفية. والهدف من الدراسة هو أستخدام الجلوبيولين المناعي G كدليل وراثى مبكر لتحسين بعض صفات إنتاج البيض في دجاج النورفا. تم تقدير تركيز كل من الجلوبيولين المناعي (IgG)G، وتركيزAb titers فى سيرم الدم لكل فرد عند عمر 20 أسبوع. تم تقسيم بدارى الدجاج إلى ثلاثة مجاميع، مجموعة المقارنة، مجموعة عالية المناعة، والمجموعة المنخفضة المناعة على أساس تركيز IgG في سيرم الدم.

تم مناقشة النتائج ولخصت فيما يلى:

1- كان متوسط تركيز كل من Ab titer, IgG في سيرم الدم في دجاج النورفا 10.424، 13,871 (مليجرام/مل)، على التوالي، وكانت نسبة تركيز IgG تمثل 75,1% من مجموع تركيز Ab titer، كان تركيز IgG 13,500، 7,576، 1,195 (مليجرام/ مل) في المجموعة عالية المناعة، والمجموعة المنخفضة المناعة ومجموعة المقارنة، على التوالى.

2- أدى استخدام التركيز العالى من الجلوبيولين المناعي (IgG) G (في المجموعة عاليه المناعة) كدليل وراثى مبكر إلى تحسين صفات التبكير في العمر عند النضج الجنسي بنسبة (10,00أيام)، وخفض وزن الجسم عند النضج الجنسي بنسبة (10,4%)، وخفض وزن الجسم عند النضج بنسبة (9,0%)، وزيادة كتلة البيض عند عمر 90 يوم من الوضع بنسبة (25,4%) وعند عمر 42 أسبوع من الفقس بنسبة (22,4%) بالمقارنة بمجموعة المقارنة.

3- يمكن إستخدام تركيز الجلوبيولين المناعي (IgG) G كدليل وراثى جيد لتحسين بعض صفات إنتاج البيض وذلك نتيجة لارتباطه الموجب بمعظم الصفات الإنتاجية في الدجاج.

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