Annals of Agric, Sc, Moshtohor, *ISSN 1110-0419*
Vol,48(2):An 1 -11 (2010)

THE INTERACTION EFFECT OF STRAIN, SEX AND LIVE BODY WEIGHT ON ANTIBODY RESPONSE TO $SRBC_S$ IN BROILER CHICKENS

K. M. Eid, A. A. Radwan, G.M. Gebriel[*] and M. M. Iraqi

Fac. of Agric. Animal Production Dept., Benha Univ.
[*]Fac. Of Agric. Poultry production Dept., El-Menufiya Univ.

Abstract:

An experiment was designed to evaluate the effect of both strain and sex against of SRBCs antigen on live body weight, at different ages in broiler chickens. The experimental extended from June to July 2007, in order to investigate the relationship between the general immune response to SRBCS antigen on body weight traits in broiler chicks at one cycle. Two different commercial strains (ISA Hubbard and Ross 308) were used. Chicks were brooded and reared under similar environmental condition and raised on deep litter up to marketing age (7 weeks). The feed and water were provided *ad libitum*. Individual body weight of 500 chicks was recorded for each strain (250 per each) separately at 0, 1, 2, 3, 4, 5, 6 and 7 weeks of age. Prepared antigen (SRBC 2.5%) was injected individually in all birds with 0.13 dose at 28 day of age. Then, chickens were bled from the wing vein at 7, 14 and 21 day post- injection for anti-body (Ab) levels determination. Means of Ab – titers were 6.91 and 5.66 at 7-d post – injection in ISA Hubbard and Ross 308, respectively, with highly significantly differences ($p \leq 0.001$) between strains. While, females had higher Ab – titers than males, but the difference were not significant. On other hand, Ab - titers at 7, 14 and 21 - d post injection in both broiler strains had negative phenotypic correlations with body weight at 7- Wks of age, being – 0.049, – 0.008 and – 0.041, respectively.

INTRODUCTION

One of the concerns of commercial poultry farmers is the protection of their flocks against disease challenge. This objective could be achieved through selecting birds that are resistant against particular pathogens, and/or those displaying better immunocompetence, i.e., the general quality of host's immune system to launch sufficient defense against infections **(Knap and Bishop, 2000)**. Previous studies have linked genetic makeup of poultry to disease resistance and/or susceptibility(**Lamont *et al.*, 1987; Lakshman *et al.*, 1997; Poulsen *et al.*, 1998; Yonash *et al.*, 2001).** Furthermore, genetic improvement for growth performance over the years has been seen to negatively influence immune performance of chickens. High

growth rate in broiler chickens has also been linked to increased susceptibility for Marek's Disease **Gebriel et al., 1979** and Presently, the aim of commercial poultry breeding is to achieve higher body weight and maximum egg production per unit of feed intake. However, there is a negative correlation between production traits and immunity in chickens because of the conflict between some production and immunity, i.e. maturation and function of the immune system. The genotypes with the maximum body weight exhibit lower immunity **(Gebriel, 1990 and Nestor *et al.*, 1996)**

Mortality due to Marek's Disease challenge showed higher in males than in females of B^{13} B^{21} Cornell Random bred White Leghorn chickens divergently selected for low antibody response to SRBC signifying a sex effect in disease susceptibility **(Martin *et al.*, 1989).** Furthermore, age of the chickens also has an effect on immune performance. Due to immunological immaturity, young chickens have a greater incidence of diseases such as infectious bursal disease, avian encephalomyelitis, Marek's Disease, *E. coli* and Salmonella infections **(van der Zijpp, 1983).**

MATERIALS AND METHODS

1.Genetic stocks and management:

The experiment of this study was carried out at Private Breeding Farm of poultry production Toukh city, Kaluobia Governorate, Egypt, during 49 days in summer 2007, in order to investigate the relationship between the general immune response to $SRBC_S$ and some productive traits in broiler chicks. Two different commercial strains, named ISA Hubbard and Ross 308, were used. Data collected from 500 chicks (250 chicks from each strain) were used. All chicks were brooded and reared under similar environmental conditions and raised on deep litter up to marketing age (7 weeks). Feed and water were provided *ad libitum.* They were fed a diet containing 23% crude protein and 3000 k.cl ME/kg in starter formula, 21% crude protein and 3050 k.cl ME/kg in grower formula and 19% crude protein and 3150 k.cl ME/kg in finisher formula. The load number was (intensity numbers 10 birds /m^2). All chicks exposing to similar environmental condition during experimental period.

2. Immunization with $SRBC_S$ antigen:

Sheep red blood cells ($SRBC_S$) were chosen as natural immunizing antigen to elicit the antibody response in the chicks. The prepared $SRBC_s$ antigen (2.5%) was injected individually in the wing vein with 0.13 ml at 28- day of age according to the method of **Van der Zijpp and Leenstra (1980)**.

Studied traits

1. Body weights:

Individual body weight was recorded for each strain separately at 0, 1, 2, 3, 4, 5, 6, 7, weeks of age. At 5- wk of age chicks were divided into three lines (light, control and heavy) for body weight according to (mean ± S.E).

2. Determination of antibody response:

The primary antibody titer to $SRBC_S$ was determined for all individuals at 5- weeks of age. Blood sample were collected at 7, 14, and 21-day post- immunization with a syringe from the wing vein. About 2-3 ml of blood were taken from each chicken, serum was collected and antibody titers were determined using micro haemagglutinin as described by **Van der Zijpp and L eenstra (1980)** method.

Antibody titer was expressed as $\log_2$ of reciprocal of the last serum dilution showing haemagglutinin.

3. Statistical analysis:

Data were analyzed using the General Linear Models (GLM) procedure of SAS software **(SAS Institute, 1996)**. Differences among means were tested based on Duncan test, **(Duncan, 1955).**

Results and Discussion

1. Effect of strain and sex on body weight before SRBCs injection:

Means of body weight were ranged from 38.95 to 907.2g and 36.7 to 827.4 g at hatch to 4- wks of age in ISA Hubbard and ROS 308 strains respectively (**Table 1).** On the other hand, means of body weight in males were (38.61 and 891.26 g), but in females were (37.08 and 843.35 g) at hatch and 4- wks of age, respectively (**Table 1).**

Results in (**Table 2)** showed that, the statistical difference between the two strains and sex effect were highly significant ($P<0.001$) in live body weight at different ages (from hatch up to 4- wk of age). While, the interaction between strain and sex effects was highly significant ($p\leq 0.001$) in live body weight at 1^{st}, 2^{nd}, 3^{rd} and 4^{th} weeks of age **(Table 2).**

These results agree with **Gavora, (1993)** who found that, body weight in chickens is a typical quantitative trait, affected by many genetic, as well as environmental factors. Others **(Dunnington *et al.*, 1986; Leitner *et al.*, 1992; Pinard *et al.*, 1993; Parmentier *et al.*, 1996)** have demonstrated the feasibility of selection based on body weight and suggested that it may improve disease resistance. However, the immunocompetence of such lines has never been reported under farm condition.

Table (1):Least square means of strain and sex effects on live body weight at different ages.

Effect	Age of chicks				
	At hatch	1- WK	2-WK	3-WK	4-WK
Strain effect					
ISA Hubbard	38.95 ± 0.11	162.34 ± 0.61	3 12.22 ± 1.66	553.65 ± 2.85	907.22 ± 3.16
Ross 308	36.74 ± 0.11	154.15 ± 0.61	258.47 ± 1.69	496.91 ± 2.88	827.40 ± 3.20
Sex effect					
Male	38.61 ± 0.12	179.39 ± o.61	310.04 ± 1.67	558.41 ± 2.87	891.62 ± 3.18
Female	37.08 ± 0.12	137.37 ± 0.61	260.66 ± 1.67	492.15 ± 2.87	843.35 ±318

Table (2): F- rations of least square analyses of factors affecting live body weight at different ages.

S.O.V	Body weight[+]									
	WK0		WK1		WK2		WK3		WK4	
	d.f	M.S	d.f	M.S	d.f	M.S	d.f	M.S	d.f	M.S
Strain	1	562.0***	1	7755.6***	1	334283.4***	1	372547.7***	1	737256.8***
Sex	1	270.8***	1	206756.5***	1	282226***	1	507967.4***	1	265697.3***
Strain × Sex	1	25.7ns	1	4466.2***	1	61197.6***	1	136073.3***	1	101126.3***
Error d.f	489		479		475		467		462	
Error M.S		3.2		86.4		650.1		1905.2		2345.6

ns = non significant, *** = p<0.001.

[+] WK0, WK1, WK2, WK3 and WK4 = body weight at 0, 1, 2, 3 and 4 weeks of age, respectively.

2. Effect of strain and sex on live body weight after SRBCs injection:

As shown in (**Table 3),** chicks of ISA Hubbard had heavier body weight than Ross 308 strain at 5 to 7 weeks of age reaching the highest body weight at 7- wk being 1636.8 g for Hubbard and 1529.40g for Ross. The difference between the two strains of chickens was highly (P≤0.001) significant (**Table 5)**.

Furthermore, body weight average of males of both ISA Hubbard and Ross 308 strains was heavier than female at 5 and 6 weeks of age, after injection with SRBC (**Table 3)**. In spite of, the difference between males and females in body weight was non-significant at 5 and 7-wk of age, but it was highly significant (p≤0.001) at 7- wk of age (**Table 5)**. This may be due to the fast growing of males than females (**Brake *et al.*, 1993).**

Results in (**Table 4)** showed that chicks had high antibody titers were low in body weight compared with low and, control antibody levels. The difference between both low line (LL) and control (CL) and high lines (HL) was significant (P≤ 0.05) at different age **(Table 4).** These results agree with the results reported by **Parmentier *et al.*, (1998**) who found that the high immune response line chickens

were significantly lower in body weight at 38 WK of age than the control and low line selected for antibody response to $SRBC_s$. In addition, there was no significant difference in interaction between strain x line, sex x line and strain x sex x line in body weight. However, these interactions were ignificant ($P \leq 0.05$) at only 7- wk of age.

Table (3): Least square means of strain and sex effect on live body weight at different ages against $SRBC_S$ injection.

Effect	Age of chickens		
	5-WK	6-WK	7-WK
Strain effect			
ISA Hubbard	1307.01 ± 4.0	1506.8 ± 3.82	1636.83 ± 7.21
Ross 308	1174.50 ± 3.44	1376.1 ± 3.90	1529.40 ± 6.16
Sex effect			
Male	1243.13 ± 3.7	1444.88 ± 3.51	1599.02 ± 6.63
Female	1238.37 ± 3.8	1436.73 ± 3.52	1567.20 ± 6.78

Table (4): Least square means of live body weight at different ages as affected by antibody titer levels (low, control and high).

Line[+]	Age of chickens		
	5- wk	6- wk	7- wk
Light	1235.49± 3.83 b	1438.63 ± 3.94 b	1579.34 ± 6.89 b
Control	1243.45± 3.99 b	1442.12 ± 4.12 b	1583.78 ± 7.15 b
Heavy	1243.32± 5.69 a	1443.66 ± 5.88 a	1586.21± 10.20 a

Means with the same letters in each column are non- significantly difference ($p<0.05$)

[+] Low level (0: 3.3), control level (3.4: 9.3) and high level (9.4: >). These levels were distributed according to (mean ± S.E).

Table (5): Analyses of variance of strains, sex and antibody level affecting live body weight at different ages after injection with $SRBC_S$ age.

S.O.V.	WK5		WK6		WK7	
	d.f	M.S	d.f	M.S	d.f	M.S
Strain	1	*** 1685364.1	1	*** 1616110.09	1	*** 1086445.89
Sex	1	ns 2182.37	1	ns 8471.19	1	*** 95383.73
Level	2	ns 3315.44	2	ns 902.06	2	ns 1585.38
Strain x Sex	1	*** 8317.02	1	*** 6582.45	1	*** 7579.52
Strains x level	2	ns 3101.99	2	ns 2882.18	2	ns 26869.90
Level x sex	2	ns 37398.90	2	ns 42480.19	2	* 109980.34
Strain x Sex x level	2	ns 834.22	2	ns 1677.74	2	* 23899.85
Error	450	2674.37	446	2841.4	412	8628.26

ns = non significantly, * = P<0.05 , *** = P<0.001

3. Effect of strain and sex on titers of antibody after injection with $SRBC_S$:

The means of antibody (Ab) titers of ISA Hubbard was higher than ROS 308 strain at different ages (7, 14, and 21 days) post injection **(Table 6).** In genetically, the highest level of Ab- titers occurred at 7- days post- injection, then declined gradually to 21- days post-injection in all chickens of

returned to sensitivity degree of strains aga both strains. The difference of Ab titers between the strains was highly (P<0.001) significant (**Table 7).**These results may be inst SRBC injection and immune system activation which differs from strain to another, this agree with results of **Shadi (2006**) on the same strains.

On the other hand, the Ab titers of females were higher than males at 7, 14 and 21 days post injection **(Table 6 and Fig.1)** but the difference between them was not significant **(Table 7).** The same results showed by **(Siegel and Gross, 1980; Leitner *et al*., 1992; and Parmentier *et al*., 1996)** in chickens**.**

Table (6): Least square means of antibody titer after injection with SRBC at different age as affected by strain and sex effect.

Factor	Age of chickens		
	Ab-7 d	Ab -14 d	Ab -21 d
Strains effect			
ISA Hubbard	6.91 ± 0.19	4.0 ± 0.12	2.19 ± 0.05
Ross 308	5.66 ± 0.19	3.1 ± 0.12	1.79 ± 0.05
Sex effect			
Male	6.06 ± 0.19	3.32 ± 0.12	1.89 ± 0.05
Female	6.51 ± 0.19	3.76 ± 0.12	2.1 ± 0.05

Table (7): Analyses of variance of factors affecting antibody titers after injection with SRBCs at 28 day of age.

S.O.V	Ab 7d		Ab14d		Ab 21d	
	d.f	M.S	d.f	M.S	d.f	M.S
Strain	1	*** 180.22	1	*** 94.68	1	*** 17.93
Sex	1	ns 23.78	1	ns 22.11	1	ns 4.95
Strains× sex	1	ns 0.26	1	ns 0.494	1	ns 0.70
Error	459	8.27	457	3.63	454	0.78

ns = non significant *** = p<0.001

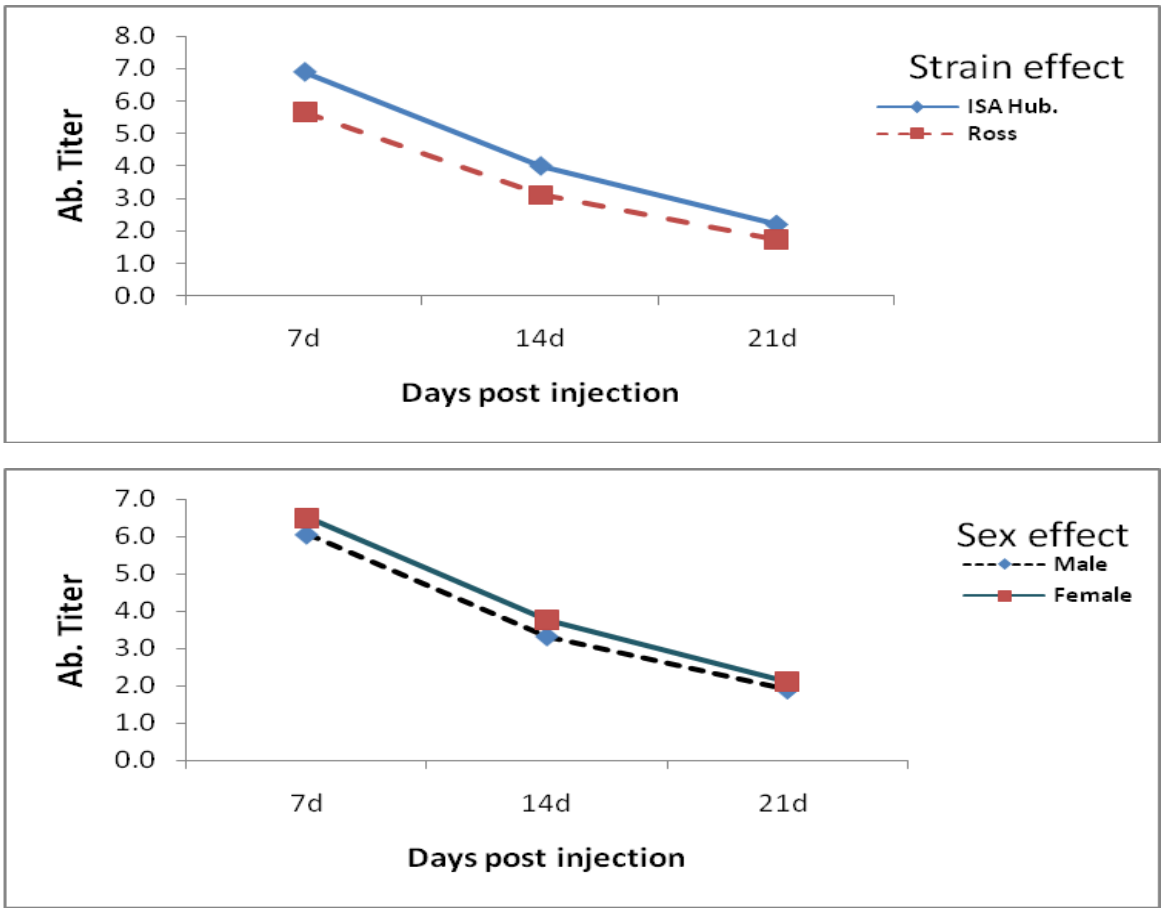

Fig.(1) Effect of both strain and sex on Ab titers at 7, 14 and 21-d post injection.

4. Phenotypic correlation between live body weight and antibody titer.

Results in **Table (8)** cleared that low and negative phenotypic correlations were obtained between antibody titers and live body weight at 7- wk of age. The negative phenotypic correlations may affect fitness sexes that can develop between the selected trait and correlated trait due to source in balance **(Rendel, 1963)**. The negative phynotypic correlation between growth and antibody response to $SRBC_s$ has been demonstrated in several experimental lines of chickens **(Marstellar *et al.*, 1980; Siegel *et al.*, 1982; and Van der zijpp *et al.*, 1988)**. This study stated that the genotypes with maximum body weight exhibit lower immunity.

Table (8): Phenotypic correlation between of antibody titer and live body weight at different ages in broiler chickens after injection with $SRBC_s$.

Item	Antibody titer		Live body weight		
	Ab 14-d	Ab 21-d	5- wk	6- wk	7- wk
Ab 7-d	*** 0.506	*** 0.496	0.148	0.160	- 0.049
Ab 14-d		*** 0.669	0.188	0.188	- 0.008
Ab 21-d			0.196	0.193	- 0.041

*** = $P \leq 0.001$

REFERANCES

Brake, J., G. B. Havenstein, S. E. Scheideler, P. R. Ferket, and D. V. Rives, (1993). Relationship of sex, age, and body weight to broiler carcass yield and offal production. Poultry Sci. 72: 1137–1145.

Dunnington E.A., W.E. Briles, R.W. Briles, and P.B. Siegel. (1986). Immunoresponsiveness in chickens: association of antibody production and the B system of the major histocompatibility complex. Poult. Sci. 75:1156-60.

Duncan, D. B. (1955). Multiple range and multiple F- test. Biometices, 11.1

Gavora, J. S., 1993. Genetic control of disease and disease resistance in poultry. Pages 231–241 *in*: Manipulation of Avian Genome. R. J. Etches and A. M. Verrinder-Gibbins, ed. CRC Press, Boca Raton, FL.

Gebriel, G.M., (1990). The chicken MHC haplotypes.a. Genetic parameters of immune response to $SRBC_S$ antigen within the B blood groupgenotypes. Egyptian I. Appl. Sci., 5:290- 298.

Gebriel, G.M., I.Y Pevzner and A. W-Noedskog (1979). genetic linkage between immune response to GAT and the fate of RSV- induced tumors in chickens. Immunogenetics, 9: 327-334.

Knap, P.W.; and Bishop, S.C. (2000). Relationship between genetic changes and infectious disease in domestic livestock. In: The Challenge in Animal Production. Occasional Publication No. 27. W.G. Hill, S.C. Bishop, B. McGuirk, J. C. McKay, G. Simm and A.J. Webb, ed. British Society of Animal Science, Edinburgh, UK. P.P 65-80.

Lakshman, N., J. S. Gavora and S. J. Lamont (1997). Major histocompatibility complex class II DNA polymorphisms in chicken strains selected for Marek's disease resistance and egg production or for egg production alone. Poult. Sci., 76: 1517-1523.

Lamont, S.J., Bolin, C. andCheville, N. (1987). Genetic resistance to fowl Cholera is linked to the major histocompatibility complex Immunogenetics 25:284-289.

Leitner, G., Z. Uni, Z. Cahaner, M. Gutman , and E. D. Heller, (1992). Replicated divergent selection of broiler chickens for high or low early antibody response to *Escherichia coli* vaccination. Poultry Sci. 71:27–37.

Marsteller, F. A., P. B. Siegel, and W. B. Gross, (1980). Agonistic behavior, the development of the social hierarchy and stress in genetically diverse flocks of chickens. Behav. Processes 5:339–354.

Martin, A., Gross, W.B. and Siegel, P.B. (1989). IgG and IgM responses in high and low antibody selected lines of chickens. J. Hered. 80: 249-252.

Nestor, K.E., D.O. Noble, J. Zhu andN.Moritsa (1996). Direct and correlated responses to long-term selection for increased body weight and egg production in turkeys. Poult. Sci. 75:1180-1191.

Parmentier, H.K., Nieuwland,M.G.B., Rijke, E., De Vries Reilingh, G. and Schrama, J.W. (1996). Divergent antibody response to vaccines and divergent body weights of chickens lines selected for high and low humoral responsiveness to sheep red blood cells. Avian Dis. 40:634-644.

Parmentier, H. K.; Mechteld, W.; and Nieuwland, M. G. B., (1998). Antibody responses and body weights of chicken lines selected for high and low humoral responsiveness to sheep red blood cells. 1. Effect of Escherichia coli lip polysaccharide. Poult. Sci. 77:24-255.

Pinard, M.H., Van Arendonk, J.A.M., Nieuwland, M.G.B. and Van der Zijpp, A. J. (1993). Divergent selection for humoral responsiveness in chickens: distribution and effect of major histocompatibility complex types. Genet. Sel. Evol. 25:191-203.

Poulsen, D. J. . Thureen, D.Rand Keeler , C.L. (Jr) 1998. Comparison of disease susceptibility and resistance in three lines of chickens experimentally infected with infectious laryngotracheitis virus. Poult. Sci. 77:17-21.

Rendel, J. (1963). An example of changes in the genetic composition of a cattle breed due to one popular bull. *Acta Agr Scand*, **13**, 227238.

SAS Institute, (1996). JMP Statistics and Graphics Guide. Version3.12. SAS Institute, Cary, NC.

Shadi, S.A. (2006): Productive performance and immunocompetence of some broiler strains under summer conditions of Egypt. M.Sci.Thesis Fac.Agric., Ain Shams Univ.

Siegel, P.B.; and Gross, W.B., (1980). Production and persistence of antibodies in chicken to sheep erythrocytes .1. Directional selection. Poult. Sci. 59, 1-5.

Siegel, P.B.; Gross, W.B.; and Cherry, J.A., (1982). Correlated responses of chickens to selection for production of antibodies to sheep erythrocytes. Anim. Blood Groups and Biochemistry Genetics 13:291-297.

Van der Ziipp, A. J., (1983). Breeding for immune responsiveness and disease resistance. Word's Poult. Sci. J. 39:118-131.

Van der Zijpp, A.J;. and Leenstra, F.R., (1980). Genetic analysis of the humoral immune response of White Leghorn chicks . Poult. Sci.,9:1363-1369.

Van der Zijpp, A. J., J. J. Blankert, E. Egberts, and M.G.J. Tilanus, (1988). advances in genetic disease resistance in poultry. Pages131–138 *in*:Advances in.Animal Breeding. S. Korver, H.A.M.van der Steen, J.A.M. van Arendonk, H Bakker , E. W. Brascamp,and J. Dommerholt , ed. Pudoc Wageningen, Wageningen,

Yonash, N., Cheng, H.H., Hillel, J. and Cahaner, A. (2001). DNA microsatellites linked to quantitative trait loci affecting antibody response and survival rate in meat-type chickenPoult. Sci. 80:22-28.

تأثير تفاعل السلالة والجنس ووزن الجسم الحي علي استجابة الأجسام المضادة لـ SRBCs في دجاج اللحم

كمال مصطفي عيد ، أحمد رضوان أبو السعود ، جودة جبريل* ، محمود مغربي عراقي

قسم الإنتاج الحيواني – كلية الزراعة – جامعة بنها

***قسم إنتاج الدواجن – كلية الزراعة – جامعة المنوفية**

الملخص العــربـى

تم إجراء هذا البحث لتقييم تأثير كل من السلالة والجنس ضد انتيجين كرات الدم الحمراء للأغنام (SRBCs antigen)علي وزن الجسم الحي في دجاج اللحم عند أعمار مختلفة. إمتدت التجربة من يونيو إلي يوليو 2007 وعلي مدار دورة تربية واحدة من أجل معرفة العلاقة بين الاستجابة المناعية العامة للانتيجين SRBCs علي صفات وزن الجسم الحي لدجاج اللحم. تم استخدام اثنين من السلالات التجارية المختلفة (ايزا هابرد و روس 308). وتك تحضين وتربية الأفرخ تحت ظروف بيئية متماثلة حتي عمر التسويق (7 أسابيع) كما زود الغذاء والماء حتي الشبع. تم تسجيل وزن الجسم الفردي لعدد 500 فرخ (250 من سلالة) عند أعمار 0، 1 ، 2، 3، 4، 5، 6، 7 أسابيع . كما تم حقن لأنتيجين المعد (ERBCs 25%) في جميع الطيور وبجرعة 0.13 عند عمر 28 يوم. أخذت عينات الدم من ويد الجناح وعلي أعمار 7 و 14 و 21 يوم بعد الحقن وذلك لتقدير مستويات الأجسام المضادة بالدم. أعطت سلالة الأيزاهابرد متوسطات تتر – الجسم المضاد أعلي من الروس 6.91 و 5.66 علي التوالي وذلك عند عمر 7 أيام بعد الحقن. وكانت الفروق بين السلالات ($P\leq0.001$) عالية المعنوية . في حين كان تتر- الجسم المضاد أعلي في الإناث من الذكور لكن دون اختلاف معنوي. وعلي الجانب الأخر أعطي تتر الجسم المضاد ارتباط مظهري سالب لكلا السلالتين عند أعمار 7و 14 و 21يوم بعد الحقن وبقيم 0.049و -0.008 و -0.042 علي التوالي.