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STRAIN VARIATION IN YOUNG CHICKENS IN RESPONSE TO CHRONIC HEAT STRESS CONDITIONS

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SUMMARY

An expriment was conducted to assess the relationship between different chicken strains and the response to extreme heat stress conditions. Two chicken populations differing in body size, the White Baladi strain and a commercial broiler strain, were used in the present study. Chicks of both populations were randomly distributed at hatch and placed in four rooms. Chicks in two rooms were exposed to 37°C to 38°C from hatch to six weeks of age.The other two rooms (control chicks) were kept at normal temperature(32°C at first week and decreased gradually to 24 oC at 4 week and then constant upto 6 week) for raising chicks.Body weights,Plasma concentration of T3 and T4 and antibodies against NewCastle disease vaccine (NCDV) were evaluated at different ages.Strain, temperature and strain-temperature interaction significantly affected traits under study. The heat stressed broiler chicks were significantly smaller than the control at 2, and 6 weeks. However,the heat stressed broilers had a faster growth rate than the non-heat stressed broilers after the environmental temperature was returned to normal at six wks of age. Plasma T3 level of the heat stressed broilers at 6 week of age was significantly at $P<0.05$ (.40 ng/ml)than the normally growing birds (1.09 ng/ml). Whereas, T4 level was not affected by high temperature. Antibody titer of the heat stressed broilers against NCDV was lower than that of broilers and White Baladi under normal temperature. Also White Baladi had higher antibody titer than that of broilers under both of heat stress and non-heat stress conditions. No significant differences due to high temperature were found in body weights and Plasma T3 and T4 levels in the White Baladi strain, indicating the superurity of the White Baladi chicks for heat tolerance.

Keywords: Strain variation, body weight, T3, T4, immune response, heat stress

INTRODUCTION

Breed differences in resistance to high temperature are associated with variations in body weights where large sized strains such as commercial broilers have less heat tolerance than small sized strains (Washburn, 1980; Meltzer, 1987), but this association was not consistent (Washburn, 1985).Therefore, the genetic variation in body size may be confouneded with other genetic differences in resistance to heat stress.However ,body weight variation within the breed was larger under heat stress environments and was a combination of normal genetic variation in body weight and response of body weight to heat stress conditions(El-Gendy,1992). The effect of heat stress on body weight was shown to be sex dependent ,being less severe in females,and was also positively correlated with age (Gross and Siegel, 1980; Ernst et al., 1984; Washburn1985; El-Gendy,1992).

The thyroid gland plays an important role in the response of chickens to heat stress conditions. Triiodothyronine (T3) was found to be the principle metabolically active hormone and the decline in heat production and feed intake are related to the decline in plasma T3 level (Williamson et al.,1986). The ability of young chickens to withstand heat stress is decreased under conditions of hyperthyroidism and is increased under conditions of hypothyroidism (Bowen et al., 1984). Heat exposure also decreases the humoral response of chicks (Shane, 1988). Birds failed to develop immunity to Fowl Pox when inoculated with Fowl Pox vaccine and then exposed to 30°C for 10 hours (Kadymov and Aleskerov, 1989). The present study was conducted to assess the relationship between strain differences in body weight and some physiological parameters and their resistance to heat stress conditions.

MATERIALS AND METHODS

Populations and Environments:Two populations of chickens were used, the White Baladi (WB) strain described by Al-Mufti (1978) and commercial broiler (BR) strain. One-day old chicks of each population were wing-banded and randomly divided into two groups that were placed for eight wks in either a heat stress (HS) environment or non-heat stress (N-HS) environment. A total of 300 chicks from both populations were intermingled and placed in the HS environment which consisted of two floor pens (3x 3x 2.8 m, each) in a conventional-type house in which the relative humidity and air velocity varied with the outside environment. The target ambient temperature in the HS environment was 37°, to 38°C from hatch to six wks of age, however due to the type of the house, the daily actual minimum and maximum ambient temperature was as following. The weekly averages for minimum and maximum temperatures were 36.6°C and 40.3°C during the first wk, 35.1°C, and 39.9°C during the second wk, 37.3°C, and 41.9°C during the third wk, 36.1°C, and 39.5°C during the fourth wk, 36.4°C, and 40.5°C during the fifth wk and 37.0°C,and 43.3°C during the sixth wk. This high temperature was turned off at six wks and the heat stressed chicks were then raised under normal temperature for two more wks. A total of 275 chicks of both populations were intermingled and placed in the NHS environment which consisted of two floor pens similar to those used for the HS environment. The N-HS chicks were was kept at normal temperature for raising broilers under 32°C for the first week and then decreased by 2°C/week to 24°C which was then maintained for the duration of the experiment.

Management: All chicks were fed ad libitum a commercial broiler diets from hatch to eight wks of age. The pan-type feeders were used in each floor-pen.Water was provide ad. lib. using jugs during the first two wks and plasson automatic waterers until eight wks of age. Lighting was continuous during the experimental period using 60 watt incandesent bulbs as a source of light in each room. All chicks were sexed at six wks of age.

All chicks were vaccinated at 7 day against NewCastle disease using the drinking water method by a B1 strain

NewCastle vaccine. At 10 days of age, they were revaccinated by a 0.5 ml NewCastle inactivated oil base vaccine injected under the skin on the back of the neck. Measurement: Chicks in each treatment were individually weighed at hatch, two ,four six and eight wk of age. Individual body weight gain (BWG) were calculated for each two wk intervals.Mortality was recorded daily and summarized, by treatment, for each 2-wk period. Five birds from each population were randomly selected from each room each week and bled by heart puncture to monitor the humoral immune response to NewCastle disease vaccine (NCDV). Hemagglutination inhibition (HI) antibodies titer were done by beta procedure in U-bolton microtiter plates. The HI test was prepared according to the procdure described by Beard(1980). Serial towfold dilution of Sera of blood sample in Phosphate Buffer Saline (PBS),begining with a 1:2 dilution were accomplished using 50 ul volumes. A fixed amount of diluent, Allantoic Fluied (AF) (8 HA unites in 50 ul) was added to the serum dilutions, the mixtures were slightly shaken and allowed to stay at room temperature for 20 minutes,and then 50 ul of 0.5% RBS suspension was added. The results were read after 30 minutes at room temperature.

The HI positive exhibted a tight, well-circumscribed button of unagglutinated,sedimenated erythrocytes,while HI negative exhibited a diffuse sheed of agglutinated erythrocytes. The HI titer was determined on all individual chickens, and the geometric mean (GMT) of each group was calculated according to Steele and Torrie (1960), as follows:

GMT = (x1. x 2. x3........xn) 1/n where
x=volume of the observation
n=number of the observation

The blood samples taken at six wks were also used to determine the plasma T3 and T4 levels.

Statistical Analysis: Analysis of variance was computed using the General Linear Model (GLM) procdure of the statistical Analysis System (SAS.1986). The model used was:

$$Y_{ijkl} = U + B_i + T_j + S_k + BT_{ij} + BS_{ik} + TS_{jk} + BTS_{ijk} + e_{ijkl}$$

where Y is the dependent variable under study B, T, and S are the effects of strain temperature and sex, respectively and BT, BS, TS and BTS are their interactions. The term denotes to the random variation among individuals within strain, sex and environment.

RESULTS AND DISCUSSION

Growth Performance

The 2-wk body weight of broiler chicks was significantly ($p<0.05$) depressed due to the heat stress conditions by 18 g (8.2%) of the corresponding controls (Table 1). This depression was positively age dependent throughout the study period and reached to 200 g (19.6%) with the continous heat exposure till six wks of age. The depression in body weight of the White Baladi chicks due to the heat exposure was only significant at two wks of age.The body weight gain of broiler chicks grown under the heat stress conditions was also significantly ($p<0.05$) depressed by 19, and 205 g (10.4 and 39.6%) during the 0-2 and 4-6wk periods respectively. The BWG of heat stressed White Baladi chicks was only depressed during the 0-2 wk period. The ratio of 4-6 wks BWG to its initial body weight at four wks of age was 0.63 for the heat stressed broilers versus 1.06 for their control grown in the N-HS environment. The ratios were 0.73,and 0.79 for both heat stressed and non-heat stressed White Baladis. This indicates that broiler chicks grown in the chronic heat stress environment were severely depressed in growth more than White Baladi chicks. These results demonstrate the dramatic effect of chronic high temperature on growth rate of young broiler chicks and also report that small sized birds are able to withstand the heat exposure more than the large sized ones. The severity of heat exposure on growth was age dependent, however age is confounded with body weight which in itself affects response to heat stress conditions. Similar results of the effects of heat stress conditions on growth rate in chickens were reported by Ernst et al. (1984). Osman et al. (1989) and El-Gendy (1992).

The 6-8 wk BWG of both broiler and White Baladi chicks grown in HS environment did not differ from their corresponding controls grown in N-HS environment (Table 1). When the ratio of 6-8 wks BWG to 6-wk BW was

Table 1. Effect of heat stress environment on growth rates (Mean±SE) of broiler and White Baladi populations

Traits	Broilers				White Baladi			
	N-HS	HS	dif	C.V.	N-HS	HS	dif	C.V.
1-day BW	39± 0.3	39± 0.3	--	7.6	33± 0.4	35± 0.5	2*	10.3
2-wk BW	220± 3.8	202± 4.4	18*	19.9	94± 1.5	83± 1.6	11*	14.8
4-wk BW	500± 9.0	505± 7.8	5	16.7	177± 2.9	181± 4.0	4	14.6
6-wk BW	1018±18.6	818±14.0	200*	16.9	315± 5.5	312± 7.3	3	14.8
8-wk BW	1337±32.1	1136±21.3	201*	19.6	466± 9.6	453±12.9	13	17.1
0-2 wk BWG	182± 3.7	163± 4.4	19*	24.2	61± 1.4	48± 1.7	13*	22.8
2-4 wk BWG	280± 7.2	304± 6.7	24*	23.4	83± 2.4	98± 3.1	15*	24.6
4-6 wk BWG	518±15.8	313±11.2	205*	30.5	138± 3.5	131± 5.1	7	22.8
2-6 wk BWG	798±17.6	617±13.9	181*	20.9	221± 5.0	229± 6.5	8	18.8
6-8 wk BWG	319±22.8	317±13.9	2*	54.6	151± 6.3	141±11.8	10	41.7
Ratio 6	1.06±0.04	0.63±0.02	0.43*	35.3	0.79±0.02	0.73±0.03	0.06	22.9
Ratio 8	0.31±0.02	0.39±0.02	0.08*	56.2	0.48±0.02	0.46±0.04	0.02	41.6

N-HS=non-heat stress environment, HS=heat stress environment.
dif=the difference between means of N-HS and HS environments within population.
Ratio 6=4-6 wk BWG/ 4-wk BW, Ratio 8 6-8 wk BGW/ 6-wk BW.
* The difference between means of N-HS and HS environments within population is significant (P≤0.05).

obtained, it was found that the heat stressed broilers significantly grew faster(0.39) than non-heated stressed broilers (0.31) during 6-8 wk period. However ratios for heat stressed and non-heat stressed White Baladis were almost similar as they were 0.46, and 0.48, respectively. These results suggest that continuous exposure to cyclic high temperature resulted in birds acquiring a heat tolerance to some degrees which enable them to withstand the heating effect. This reflects the ability of heat stressed broilers to grow at faster rate after the end of heat exposure and they might be able to compensate the loss in the growth rate over time as long as heat exposure did not damage the physiological systems. However, the White Baladi chicks did not show any decrease in growth rate under heat stress conditions which could be attributed to their normally low growth rate, compared to broilers,and that may still meet the slow growth under heat stress conditions. The coefficient of variation due to environmental temperature was higher in broiler population than in White Baladi population in eight out of ten trait comparisons (Table 1). Strain differences in body weight and its relationship to heat tolerance was also reported by Washburn (1980; 1985) Meltzer (1987).

The effect of sex and sex-temperature interaction were varied in both populations at different ages (Table 2). In broilers, males and females showed no differences in heat tolerance, however, the White Baladi females were more tolerant to heat stress conditions than did males at two wks of age. This was observed when comparing both sexes under heat stress environment or by comparing performance of the same sex in both environments.In general,there was no clear trend in the response of males and females toward growing under heat stress conditions. The ratio of 6-8 wk BWG to 6-wk body weight was more in general in White Baladi males and females than the corresponding ratios of the broilers in both environments. The ratios in broilers revealed that the heat stressed males and females gained more than their controls under non-heat stress environment, whereas the ratios of the heat stressed WB males and females were almost similar to there controls under non-heat stress environment. The cofficient of variation, by trait, was in general higher in females than in males as well as in broilers than in White Baladis. The effect of

Table 2. Effect of sex-temperature interaction on the growth rate of the broiler (BR) and White Baladi (WB) populations

Strain	Trait	Males				Females				♂	♀
		N-HS	HS	Fold	C.V.	N-HS	HS	Fold	C.V.	N-HS	HS
	2-wk BW	222a	193b	0.87	19.5	219	209	0.95	20.2	3	16
	4-wk BW	516	517	1.00	19.6	490	497	1.01	16.5	26	20
	6-wk BW	1092a	878b	0.80	16.4	972a	775b	0.80	17.3	120*	103*
	8-wk BW	1489a	1268b	0.85	15.4	1242a	1037b	0.83	22.8	247*	231*
	0-2 wk BWG	184a	154b	0.83	23.9	180	170	0.94	24.4	4	16
BR	2-6 wk BWG	870a	685b	0.79	19.2	753a	566b	0.75	22.3	117*	119*
	6-8 wk BWG	397	391	0.99	37.4	270	262	0.97	71.3	127*	129*
	Ratio 6	1.17a	0.72b	0.63	33.2	1.01a	0.57b	0.56	36.9	0.13	0.15*
	Ratio 8	0.37b	0.46a	1.24	42.8	0.28	0.35	1.25	68.2	0.09*	0.11*
	2-wk BW	97a	83b	0.86	11.6	92a	83b	0.90	17.4	5	0
	4-wk BW	189	184	0.97	13.9	167	178	1.07	15.3	22*	6
	6-wk BW	346a	317b	0.92	13.6	290	305	1.05	16.2	56*	12
	8-wk BW	520	483	0.93	17.8	423	413	0.98	15.9	97*	70*
	0-2 wk BWG	63a	49b	0.78	17.0	59a	47b	0.80	27.5	4	2
WB	2-6 wk BWG	249	234	0.94	16.6	198b	223a	1.13	21.2	51*	11
	6-8 wk BWG	174	165	0.95	41.1	133	108	0.81	41.5	41*	57*
	Ratio 6	0.83a	0.74b	0.89	21.0	0.75	0.72	0.96	24.8	0.08	0.02
	Ratio 8	0.51	0.53	1.04	43.0	0.47	0.38	0.81	39.5	0.04	0.15

N-HS=non-heat stress environment, HS=heat stress environment.
Flod= Ratio between means of the HS and N-HS within population.
a,b Mean by temperature within sex are significantly different ($P \leq 0.05$).
Ratio 6=4-6 wk BWG/ 4-wk BW, Ratio 8 6-8 wk BGW/ 6-wk BW.
* Significant effect of sex on traits within temperature ($P \leq 0.05$).

overheating was also less evident in females than in males in the Cornell randombred population (Gross and Siegel, 1980) and in the Athens-Canadian randombred population and a broiler population (El-Gendy, 1992).

Mortality

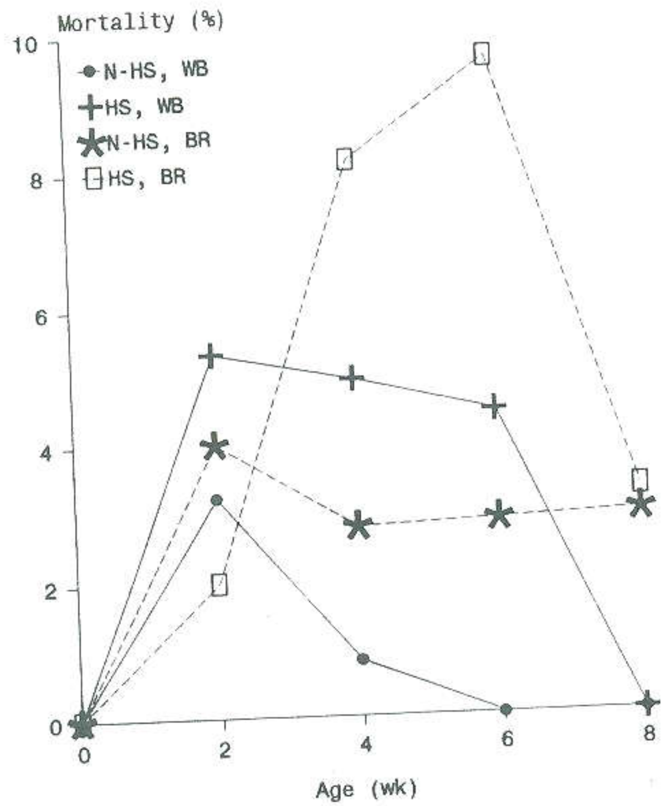
Exposure to chronic heat stress conditions resulted in increased mortality in both broiler and White Baladi chicks compard to their controls in N-HS environment (Fig. 1). The mortality of the heat stressed broiler chicks was reltively more than that of the heat stressed White Baladi chicks. The broiler chicks showed decreased mortality during the 6-8 wk period after the end of heat exposure. However the White Baladi chicks showed no mortality at the same period. Similar results were also found in the Athens-Canadian random-bred chickens and broilers under similar heat exposure conditions (El-Gendy, 1992).

Response of T3 and T4 Levels to Heat Exposure

The White Baladi population had in general significant ($p<0.05$)higher level of T3, and T4 than the broiler population and this was observed in both environments (Table 3). The White Baladi chicks had a plasma T3 of 2.19 ng/ml in the N-HS environment versus 1.09 ng/ml for broiler chicks.Level of T3 was significantly ($p<0.05$) supressed due to heat stress exposure and reached to 0.40 ng/ml in the broiler chicks. The suppression in T3 level in White Baladi was not significant. T4 in both populations were not significantly affected by chronic exposure to heat. These results are in agreement with the finding of Bowen et al. (1984) However, according to May et al. (1986) the circulating thyroid hormone level were not consistently affected by the complicated physiological response to heat stress conditions.

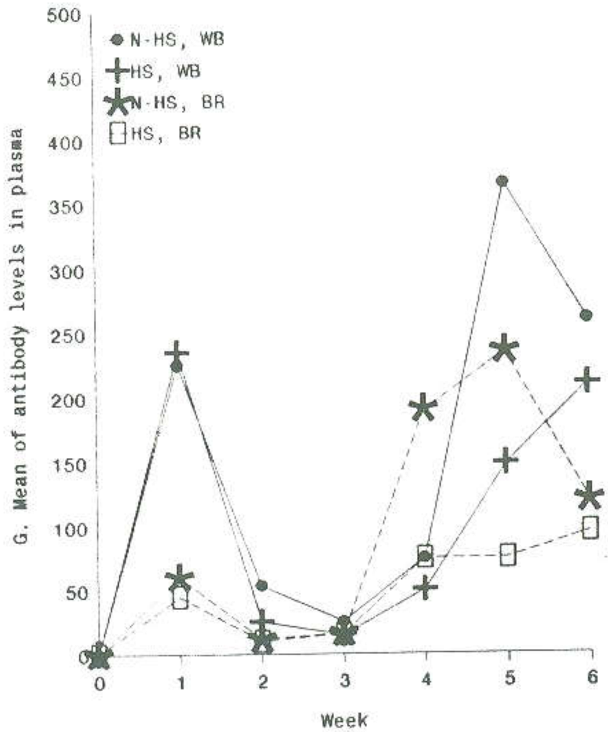
Immune Response to Heat Exposure

Both broiler and White Baladi populations developed variable degree of immunity to NCDV in both environments (Fig. 2). The White Baladi chicks developed a higher level of antibodies, by age and environments, compared to broiler chicks. The differences between both populations were higher at 1,2,5 and 6 wks of age in the N-HS environment. However the differences was significant at 5 wks of age in the HS environment. The results between strain consistent with those reported by



N-HS= non-heat stress environment
HS = heat stress environment

Figure 1. Effect of environmental temperature on mortality rates of White Baladi (WB) and broiler (BR) populations.



N-HS= non-heat stress environment
HS = heat stress environment

Figure 2. Plasma antibody levels of White Baladi (WB) and broiler (BR) in response to heating conditions.

Atta (1990), who reported that, the native Egyptian strains had significantly higher HI antibody titers than Arbor Acres chicks. This genetic variation between strains in resistence to Newcastle disease were reported early by Godfry (1952), and Cole and Hutt (1961).

Table 3. Effect of heat stress environment on the thyroid hormones of the broiler (BR) and white baladi (WB) population

Temperature	T3		T4	
	BR	WB	BR	WB
N-HS	1.09 ± 0.12^{b}	2.19 ± 0.20^{a}	1.68 ± 0.10^{b}	2.59 ± 0.19^{a}
HS	0.40 ± 0.06^{b}	1.84 ± 0.23^{a}	1.60 ± 0.09^{b}	2.30 ± 0.15^{a}
dif	0.69*	0.35	0.08	0.29
C.V.	39.40	33.40	18.30	22.40

N-HS=non-heat stress environment, HS=heat stress environment, dif=the difference between means of N-HS and HS environments within population.

^{a,b} Mean by population within temperature are significantly different ($P\leq0.05$).

* The difference between means of N-HS and HS environments within population is significant ($P\leq0.05$).

The HI antibody titers of N-HS were higher than those of HS environment, but without significant differences in each populations, except by the 5-wk age of broilers which showed significant supression in HI antibody titers in the HS environment compared to those in the N-HS environment (Fig. 2). These results show the negative response of HI antibody titers against NCDV due to heat exposure may depend on the degree of acclimation of strain.

Heat induced immunosupression is well documented (Subba-Rao and Glick, 1970, Thaxton et al., 1968 and Thaxton and Siegel, 1970 and 1973). The hypothalamic-hypophysial- edrenocorticol axis was suggested to be involved. Glick (1967), Subba-Rao and Glick (1970) and Thaxton et al. (1968) reported that the regressive influence of stress associated hormones on antibody mediated immunity.

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الاختلافات بين السلالات فى استجابتها للإجهاد الحرارى فى الأعمار الصغيرة

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استهدف البحث تقدير مدى الأختلاف بين السلالات فى استجابة الكتاكيت الصغيرة للإجهاد الحرارى الشديد.

استخدم فى هذا البحث كتاكيت من سلالتين مختلفتين فىحجم الجسم هما سلالة البلدى الابيض وسلالة بدارى اللحم التجارية (اربورايكرز) • وقسمت الكتاكيت من كل سلالة الىمجموعتين : المجموعة الأولى تم تعريضها الى درجة حرارة مرتفعة ٣٧ - ٣٨ °م كمتوسط من الفقس حتى عمر ٦ أسابيع. المجموعة الثانية تم تربيتها تحت ظروف الحضانة الطبيعية للكتاكيت لمدة ٦ أسابيع.

وقد تم تقدير وزن الجسم - هرمون الثيروكسين (T4) - الترای ايودوثريونين (T3) - الأجسام المناعية لنيوكاسل وذلك على الأعمار المختلفة تحت الظروف الحرارية المختلفة ولكلا السلالتين •

ويمكن تلخيص اهم النتائج المتحصل عليها : -

١- حدث نقص فى وزن جسم البدارى النامية تحت ظروف الاجهاد الحرارى بمقدار ١٩,٦٪ مقارنة بالنمو تحت الظروف العادية حتى عمر ٦ أسابيع

٢- معدل النمو فىالبدارى المعرضة للاجهاد الحرارى فى العمر ٦-٨ اسابيع بعد العودة لدرجة الحرارة العادية كان أسرع مقارنة بالطيور التى تم ترتيبها تحت الظروفف العادية

٣- لم يحدث اختلاف فى سلالة البلدى الابيض فى وزن الجسم ومعدل النمو نتيجة تعرض الكتاكيت للإجهاد الحرارى.

٤- انخفض مستوى الـ T3 فى دم البدارى المعرضة للحرارة عن المُرباه تحت الظروف العادية بينما لم يتأثر مستوى هرمون الـ T4 • بينما سلالة البلدى الابيض لم تظهر اىاختلافات فى مستوى T3 و T4 فى الدم وهذا يوضح قدرة البلدى على الاتزان الحرارى فى الجسم عن البدارى

٥- مستوى الأجسام المناعية فى الطيور المعرضة للاجهاد الحرارى كان أقل من مستوى الأجسام المناعية فى الطيور المرباه تحت الظروف العادية لكلا السلالتين • كما أن مستوى الاجسام المناعية فى البلدى الابيض كان أعلى من البدارى فى كلا الظروف.