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# STRAIN AND GENDER EFFECTS ON GROWTH PERFORMANCE, IMMUNE RESPONSE AND THEIR GENE EXPRESSION IN BROILER CHICKEN

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**ABSTRACT:** Due to prices fluctuations of inputs, outputs and global warming as a challenge facing poultry sector, in broiler flocks, there are several strains available to breeders' addition to sex difference.Strains and ganders differ slightly in immune-response and subsequently in productive performance. Our study investigates the cellular mediated immunity using PHA-P, some blood profiles and expression of immunity related genes (CD1b/1 & IL4I1/1) in two broiler strains. Number of six hundred chicks of Ross-308 and Cobb-500 strains was distributed as random in a completely randomized design (CRD) to 4 groups (Ross males, Ross females, Cobb males and Cobb females). At 35 day of age, blood samples werecollected randomly for gene expression and blood analysis.Our results concluded that Cobb males had the best FCR when compared to other groups. The greatest relative growth rate was obtained from Cobb males. The average of EBI, RPI and EPEF values for Ross males recorded the highest values than all other groups. At the study of immune response, the Cobb strain had significantly hyper responder to PHA-P injection compared to Ross.The blood globulin level of Cobb males had the highestvalue than other groups. Due to lipid profile; Cobb males and Ross females have the lower values of total cholesterol and Ross strain had highly significant value of total lipids. The Cobb strain had a higher total protein than Ross. The Cobb strain had higher blood Phosphorus level than Ross. At the study of molecular genetic analysis, CD1b/1 expression was higher for Ross males and Ross females than other groups andIL4I1/1 expression was higher in Ross males and Cobb females than other groups. At the end of experiment, results suggest that Ross males had more immune competence than other studied three groupsand males of both strains proved efficient to growth performance than females.

**Keywords:**Broiler, Fold Change, CD1b /1, IL4I1/1, Growth, immunity

## 1. INTRODUCTION

During genetic selection programs to increase the growth rate of broilers in the past 50 years,although modern broilers reach a marketable weight a speed twice as fast as broilers 50 years ago, the fast growth has been associated with several negative consequences such as immune response depression (Davison et al., 2011).Many strains of commercial broiler (Ross, Cobb, Hubbard, Arbor-Acres and IR) reared nowadays in Egypt. Several studies tried to inspect the strain and sex effect on Immune response and its genes expression in broiler chickens worldwide. Chicken gene expressions that control quantitative traits are affected by genetic and environment(FAO, 2009). Several genes were identified with different effects on immune response in commercial meat-type chicken.The mastery and advancement of the genetic improvement of broiler strains generated a competitive and qualified chicken meat genetics market, in which each breeding company has its selection criteria providing strains that, although similar, have particularities of their own(Obikeet al., 2016).The aim of this study was to evaluate various aspects of immune response and growth performance in (Ross 308 and Cobb 500) chickens. These included: PHA-P which evaluate the cell mediated immunity, some blood parameters and expression of CD1b/1 and Il4Il/1 geneswhich related tocell-mediated immunity and Humoral immunity, subsequently.

## 2. MATERIALS AND METHODS

### 2.1.ExperimentalSite and Time

This research was carried out at Poultry Breeding research farm, Poultry Production Department, Faculty of Agriculture, Ain Shams University, Al-Qanater; which lies between latitude 30º21 N and longitudes 31º14 E situated in the north Delta Nile in semi warm temperate zone. This experiment was conducted during the summer season from 2nd June to 7th July 2021.

### 2.2. Experimental Birds and Design

A total of 600sexed day-oldbroiler chicks of two commercial strains were purchased from a commercial hatchery. The birds were randomly divided into two sexed commercial strain groups (Ross 308 males, females, Cobb 500 males and females) of 150 birds for each group. Each group was replicated five times in a Completely RandomizedDesign of 30 birds per replicate.

### 2.3. Experimental Diets and Management:

Allbirds were fed a commercial starter diet (pellets) from 1 to 10 days of age, a commercial grower diet (pellets) from 11 to 24 days of age and commercial finisher diet (pellets) from 25 day of age until 35 day a slaughter. Feed and water for all birds were provided ad libitum.Routine vaccination, medication and management practices werefollowed.

### 2.4. Data Collection

#### 2.4.1. Growth performance

##### 2.4.1.1. Feed Cons., BWG, FCR and RGR%

The cumulative average body weight gain (BWG) was calculated for each replicate per group according to the following formula:

BWG (g) = Final BW at end period –
Initial BW at start

Cumulative feed consumption (FC) was calculated for each replicate (calculated as the difference between the amounts of feed supplied to the birds and the amount of feed that residue at the end of feeding period) according to the following formula:

FC (g/bird) = (Offered Feed – Residual Feed) / Birds No. per every replicate

Feed conversion ratio (FCR) was calculated and recorded by dividing the total cumulated feed consumed per bird by cumulated body weight gain according to the following formula:

FCR = Total feed consumed (g) per bird / Total live body weight gain (g) per bird

The relative growth rate was calculated according to the following formula (Broody, 1945):

RGR% = ((w2-w1) / ½(w2+w1))*100

Whereas; W2 and W1 refers to: Final BW at end period and Initial BW at start

2.4.1.2. Livability %

Livability (%) was calculated according to the following calculation:

Livability % = 100 – Mortality %

Whereas: Mortality % = (No. of Dead individuals / Total housed No.) * 100

**2.4.1.3. Performance Indexes (EBI, EPEF & RPI)**

Performance indexes were used to evaluate the growing performance index of broilers according to (Aviagen, 2018):

1) European Production Efficiency Factor (EPEF):

EPEF = [(Livability% * $BW_{kg}$) / ($Age_{day}$* FCR)] * 100

2) Russian Production Index (RPI):

RPI = (Meat per $m^2$ per cycle in kg * Livability%) / (FCR*10)

3) European Broiler Index (EBI):

EBI = [(Viability% * Average Daily Gain d/bird/day) / (FCR*10)] * 100

**2.4.2. Blood parameters**

At 35 day of age, 12 samples were taken (six of each strain; 3males and 3 females), approximately 2.0 ml of blood was collected from the brachial vein of birdsduring slaughtering in heparinized tubes (for Ca and P estimation) and 3.0 ml in EDTA tubes (to evaluate protein and lipid profiles; consequently, the plasma samples were separated by centrifugation (10 min X 3000 rpm). Samples were separated using automatic pipette in Eppendorftubes and stored at -20ºC even analyses. Frozen plasma were thawed at room temperature and assayed for (Protein profile: total protein, albumin & globulin) – (Lipid profile: total lipids, total cholesterol, LDL, HDL and triglycerides) – (Blood minerals: calcium & phosphorus) using kits from Spectrum Diagnostics, Egypt (Campbell, 1988).

**2.4.3. In vivo T cell–mediated immunity assay(PHA-P injection)**

Response induced in-vivo by mitogen was evaluated by injection of phytohemagglutinin-P (PHA-P) into the toe webs between the second and the third digits of birds. Ten birds from each group, at 35 daysof age were used. Each bird was intradermal injected in the toe web of the left foot with 100 µg phytohemagglutinin-P (Sigma Chemical Co., St. Louis, MO 63178) in 0.1 ml of sterile saline measured with a constant tension caliper before injection and at 24, 48 and 72 hr. after PHA-P injection. The toe web swelling was calculated as the difference between the thickness of the toe web before and after injection. The resulting swelling was interpreted as an index of cell mediated Immune competence(Tuiskula-Haavistoet al., 2002).

**2.4.4. Lymphoid organs**

At 35 days, 20 birds in total (five from each group and one bird per replicate) were chosen at random. Birds were slaughtered and lymphoid organs (spleen, thymus and bursa organs) were extracted and weighted in grams**.**

**2.4.5. Molecular immune-genetics**

**2.4.5.1. Experimental Birds**

At 35 days of age, total number of 12 broiler chickens chosen randomly

fromfour groups (3 birds for each). Three blood samples 3 ml collected randomly from each group into tubes containing Cal-heparin as a coagulant factor.

**2.4.5.2. RNA extraction and cDNA synthesis**

Pure total RNA was isolated from the samples of blood (under sterilization conditions) using total RNA purification Kit 50 preps (Thermo Fisher Scientific Inc.). Transcriptor Synthesis cDNA Kit was used for cDNA synthesis following the manufacturer instruction. Once this process was completed, cDNA was reserved at -20℃ until quantification.

**2.4.5.3. Real-time quantitative PCR**

The cDNA which obtained was quantified using the specific CD1b /1 and IL4I1/1 primers. Real-time PCR was carried out using 20 µl master-mix which consists of 10 µl SYBERGREEN(P3), 0.5µl primer (P1), 0.5 µl primer (P2), 1.2µl buffer, 6.6 µl H2O, and 1.2µl of cDNA template.

The rt-PCR cycle program performed as follow: initial denaturation at 92 °C / 2 min, repeated 40 cycles of 92 °C / 5 sec for denaturation phase, 56 °C / 15 sec for annealing phase, and 72 °C / 26 sec for extension phase. Dissociation test performed from 95 °C to 50 °C at 10 min interval to test for dimerization.

Cycle threshold (CT) calculated based on default setting of sequence detection results of real-time software. The equation of the graph used to calculate the number of cDNA molecules per microgram from mRNA-converted cDNA. The gene expression in the form of relative quantification estimated using Ct values. The fold change of target genes in comparison to control was calculated according to (Livak and Schmittgen 2001).

Primer sequences of target genes were showed in table (1). CD1b gene is related to cell-mediated immunity andIL4 gene is related to humoral immune response.

**2.5. Statistical analysis**

Data were subjected to a two-way analysis of variance using the general liner modal (GLM) of (SAS, 2006). The modal generated was fitted for the effects of strain, sex and their interaction:

$Y_{ijk}= \mu+S_i+X_j+ (S*X)_{ij}+e_{ijk}$

Where Y is the dependent variable, µ is the grand mean, $S_i$ is the fixed effect of the strain (i= 1, 2); $X_j$ is the fixed effect of the sex (j= 1, 2); $(SX)_{ij}$ is the interaction between strain and sex and $e_{ijk}$is the random error term.

## 3. RESULTS AND DISCUSSION

### 3.1. Growth Performance

#### 3.1.1. Feed Cons., BWG, FCR and RGR%

Growth performance traits are often used to assess poultry production (Zhang et al., 2018).The growth performance of different strains and genders are showed in (Table 2).The present results showed significant differences ($P < 0.01$) in cumulative weight gain, feed consumption and feed conversion ratio among the four groups of chicken. Birds of Ross males showed the highest final weight gain and feed consumption at 5 wk of age followed by Cobb males, while the Cobb males showed the best total feed conversion ratio. The feed consumption recorded a higher value in Ross strain during period (0-35) day of age when compared to Cobb strain. The male broilers consumed a highestfeed quantity when compared to female broilers during period(0-35) day of age. The females of Ross strain consumed less feed than females of Cobb strain with a highly significant interaction effect.

Livingston et al. (2020) showed that FC was higher in Ross strainduring the first week of age when compared to Cobb strain. The broiler males consumed a larger feed quantitywhen compared to females from the second week even to the six week of age.

The present study showed that broiler Cobb males had the bestfeed conversion ratio when compared to Ross females and males. Livingston et al. (2020) reported that broiler malesachieved reduced feed conversion ratio from (3-6) week of age when compared to broiler females. The Cobb and Ross broilers had a superior feed conversion ratio from 0-3 week of age. Ross strainhad a lower feed conversion ratio from 0-6 week of age when compared to Cobb strain.Khalid et al. (2021) found that the cumulative FCR was slightly better for Cobb-500 which recorded 1.4than Ross-308 which recorded 1.46.

Growth rate is one of the birds' important development signs. The greatest relative gain was obtained from Cobb males' group (192.65 %) with highly significant difference, while Ross females' group (190.07 %) had the lowest value percentage of growth.Hennet al. (2014) reported that, in Cobb strain higher growth rate % observed in males relative to females because their higher potential of weight gains.

**3.1.2. Performance Indexes (EBI, EPEF & RPI)**

The effects of strain and sex on the performance indexes are shown in Figure 1. Results show significant differences due to strain effect and sex effect in all measured Performance Indexes of Broilers.As seen from the results, the average of EBI, RPI and EPEF values for Ross males recorded the highest than all other groups with high significantly affect ($Pr<0.0001$), while these parameters were lowest in females of Ross strain.Kryeziuet al.(2018) showed that sex did not significantly affect EPEF and EBI values, although these parameters were lower in female chickens than in males.Hristakievaet al.(2014) reported that the EPEF data demonstrated that Cobb 500 birds had higher values as a higher economic efficiency than Ross 308 by 14.87 points.

**3.1.3. Livability %**

The effect of strain and sex on viability percentage was showed in (Figure 2). The females' individuals of Cobb strain proved the best livability (98.67%) than Ross strain, while males of each Cobb and Ross strains showed an intermediate value (94.67% and 93.33%) subsequently. The Ross females' chicken had the lowest livability which recorded (86.67%). On contrast of our study, (Simonaet al., 2017)proved thatRoss 308 strain had non-significant increase in viability percentage (100%) than Cobb 500 (99%).

**3.2. In vivo T cell–mediated immunity assay**

Cell-mediated immunity was measured by PHA-P stimulation (Toe-web) is shown in (Table 3).It could be noticed that the females of both strains Cobb and Ross (0.038 mm & 0.035 mm) subsequently after 24 h of tissue injection. Cobb strain had significantly ($P\leq0.02$) hyper responder to PHA-P injection compared to Ross. Broiler females shown to be effective immune response against antigens may be for its low productive performance than males. The delayed hypersensitivity skin effect for sex effect showed specific stimulation after 48 and 72 hours after inoculation with antigen. The response to PHA-P injection is decreased after 72 hours in

strain effect which Ross and Cobb recorded (0.007 & 0.009 mm) subsequently, while sex effect is delayed to 72 hours to record significant effect (males=0.005 mm & females=0.011 mm). The PHA-Pintra-dermally reaction, a T-Lymphocyte-dependent response has been well researched and shown to be a reliable indicator of in-vivo cellular immunity in chickens(McCorkle et al., 1980).

**3.3. Blood parameters:**

Table (4) shows cholesterol, HDL, LDL, triglyceride and total lipid values which measured for sexed Ross and Cobb strains. Blood plays an important role in carrying nutrient, metabolic waste, and hormonal transmission.(Khan et al., 2013 & 2014)showed that the blood biochemical profile would reflect the physiological state of the body.

It showed that the Cobb males and Ross females have the lower values of total cholesterol with non-significant decreased than others (165.23mg/dl&165.24 mg/dl) subsequently.Ross broiler strain shows to have a significant effect of HDL than Cobb strain with 59.92 mg/dl & 52.06 mg/dl), while LDL sowed non-significant decreased for Cobb strain than Ross strain. The females for both strains had a significant increased for Triglycerides level (92.46 mg/dl) than males (82.70 mg/dl).Ross strain had highly significant value of total lipids (757.14 mg/dl) than Cobb (620.24 mg/dl), while females had non-significant increase of total lipids than males.

The Cobb strain had a non-significantly higher blood calcium level than Ross strain. It could be noticed that Ross strain had a decrease calcium level compared to Cobb strain and the effect of strain and sex interaction and straineffecthadn't significant. Also, sex had non-significant affect; it showed that male individuals had low calcium level than females in both strains. Blood phosphorus levels had a significant difference between strains, sex and interaction. The Cobb strain had higher blood Phosphorus level (4.41 mg/dl) than Ross strain (3.87 mg/dl). It could be observed that males had the lower level of Phosphorusthan females for overall of both strains.

The sex and interaction had non-significant effect on blood albumin levels, while strain had a significant effect which Ross strain recorded a significant increase (2.98 g/dl) than Cobb (2.75 g/dl). The strain, sex and their interaction had non-significant effect on blood globulin levels, where the globulin of Cobb males was higher than Cobb females, Ross females and Ross males respectively. Total protein level in blood had not affected by strain, sex and their interaction, the strain effect showed that the Cobb had a higher total protein (6.18 g/dl) than Ross strain (5.99 g/dl) and the difference between strains and sexes was not significant.

**3.4. Lymphoid organs:**

The resulted percentage values of lymphoid organs are presented in Table 7. The lymphoid organs (spleen, bursa and thymus) percentage did not affectby the strain,sex and their interaction. The strain effect showed that Cobb strain had higher value of bursa and thymus than Ross, but lowerinspleen % value,while the sex effect showed that males had higher of spleen and bursa % values than females, but lowerin thymus % value.

Our results were agreed with**(**Cheemaet al., 2003)who showed that the bursa, spleen and thymus weights were not significantly different for the different strains (Cobb, Ross 308 and Ross 3F8).

The bursa of Fabricius and spleen are the major lymphoid organs in the birds, and both are participating in the cellular and humoral immunity (John, 1994). Previous reports stated that the relative weight of the spleen and bursa were decreased when the birds were subjected to different levels of thermal stress (Anwar et al., 2004).

**3.5. Immune-Genetics**

The obtained cDNA used to analyze the gene expression of the avian immune genes for samples representing in Ross and Cobb strains using the reaction primers House Keeping Gene (HKG) as an indication to know the extent of CD1b /1 and IL4I1/1expression gene changes. The quantitative analysis of gene expressions showed the achieved amplification of all samples, as shown in (Table 1). Ourresults refer to the specialty of used primers, and the amplification curves were used to have the (CT) values. The CTvalues arean amount of change in expressed genes (Figure 1).

By extracting the CT values for all samples; it was found that CT values ranged among (11.58-35.27) for the HKG as an indicator and from (15.95-30.03) for CD1b /1 gene and ranged among (10.86-37.02) for IL4I1/1 gene.

With regard to the House Keeping Gene, the (CM1, CM2, CM3 and RF2) samples achieved the highest values and the (RM3, CF1, CF2 and CF3) achieved the lowest values.

For the CD1b /1 cellular immunity related gene expression, the values were higher (CM1, CM2, CM3, RM2, RM3 and CF1) and lower values (RF1, RF2, CF2 and CF3). While the IL4I1/1 gene which related to humeral immunity showed a higher expression values for (CF1, RF3, RM1 and CM3) and lower values for (RF1, RF2 and RM3) groups.

By subtracting the CT value of CD1b /1 gene from the CT value of (HKG) to obtain (ΔCT); the (ΔCT) values ranged between (-20.45: +17.06) and by calculating the rate of change in gene expression (Fold Change) for each genetic group.The meanswere (2.43) for Ross males, (2.21) for Ross females, (2.09) for Cobb males and (2.07) for Cobb females. While the CT values of IL4I1/1 gene from the CT values of House Keeping Gene to have (ΔCT); the (ΔCT) values ranged between (-15.44: +19.97) and by calculating the fold change for each genetic group. The means were(2.26) for Ross males, (2.00) for Ross females,(2.00) for Cobb males and(2.30) for Cobb females.

The expression level of CD1b /1 gene for Ross males and Ross females were higher than other two groups. And the IL4I1/1 expression level of the gene for Ross males and Cobb females were higher than other two groups.

## 4. CONCLUSION

In conclusion, our results revealed that males of Ross strain had the best gene expression to immune genes and more immune competence than other groups, while growth performance was fluctuated between Cobb males and Ross males than females of the two strains.

**Table (1):**Primer sequences of genes used in the rt-PCR analysis

| Gene | | Primer Sequence |
|---|---|---|
| CD1b/1 | forward [a]<br>reverse [a] | 5'-TGGATCAGGGAAGGGGAAAC-3´<br>5'-GGGAGCAATAGGGTGGCTATC-3´ |
| IL4I1/1 | forward [b]<br>reverse [b] | 5'-GAGAGCATCCGGATAGTGAATG-3´<br>5'-TGTGGAGGCTTTGCATAAGAG-3´ |

a(Davison et al., 2011), b (Zhang et al., 2015).

**Table (2):**Means and (±SE) of feed consumption (FC), weight gain (BWG), feed conversion ratio (FCR) and relative growth rate (RGR) as affected by strain & sex from 0 to 35 d of age

| Item | Sex | Strain | | Overall (sex) | Prob. | | |
|---|---|---|---|---|---|---|---|
| | | Ross | Cobb | | S | X | S*X |
| Cumulative FC (g) | Male<br>cv% | 3380.22±15.91<br>3.087 | 2989.43±18.17<br>3.844 | 3191.89[a] | <.0001 | <.0001 | <.0001 |
| | Female<br>cv% | 2841.70±7.56<br>1.620 | 2974.45±10.63<br>2.233 | 2909.82[b] | | | |
| | Overall (Strain) | 3131.15[a] | 2982.03[b] | | | | |
| Cumulative BWG (g) | Male<br>cv% | 2059.65±21.70<br>6.909 | 1890.10±21.02<br>7.034 | 1977.94[a] | 0.0025 | <.0001 | <.0001 |
| | Female<br>cv% | 1656.35±15.21<br>5.586 | 1706.15±18.10<br>6.626 | 1681.91[b] | | | |
| | Overall (Strain) | 1873.13[a] | 1799.29[b] | | | | |
| Cumulative FCR | Male<br>cv% | 1.648±0.018<br>7.404 | 1.589±0.020<br>7.970 | 1.735[a] | NS | <.0001 | 0.0182 |
| | Female<br>cv% | 1.721±0.017<br>6.027 | 1.750±0.017<br>6.325 | 1.620[b] | | | |
| | Overall (Strain) | 1.682 | 1.669 | | | | |
| Cumulative RGR (%) | Male<br>cv% | 191.96±0.14<br>0.476 | 192.65±0.12<br>0.417 | 192.31[a] | <.0001 | <.0001 | <.0001 |
| | Female<br>cv% | 190.07±0.13<br>0.399 | 191.92±0.15<br>0.481 | 191.07[b] | | | |
| | Overall (Strain) | 191.12[b] | 192.33[a] | | | | |

a,b Means with different superscripts within the same column are significantly different ($p \leq 0.05$). S=Strain, X=Sex, NS= non-significant means.

**Table (3):** Means and (±SE) of Toe-web dermal swelling (difference) response of birds injected with phytohemagglutinin-P as affected by strain, sex and their interaction

| Item | Sex | Strain | | Overall (sex) | Prob. | | |
|---|---|---|---|---|---|---|---|
| | | Ross | Cobb | | S | X | S*X |
| After 24h | Male | 0.029± 0.002 | 0.030± 0.004 | 0.029 | 0.0202 | NS | 0.0500 |
| | cv% | 20.77 | 35.64 | | | | |
| | Female | 0.026± 0.005 | 0.044±0.004 | 0.035 | | | |
| | cv% | 46.28 | 21.38 | | | | |
| | Overall (strain) | 0.027 [b] | 0.038 [a] | | | | |
| After 48h | Male | 0.017± 0.004 | 0.012± 0.005 | 0.015 | NS | NS | NS |
| | cv% | 51.69 | 112.79 | | | | |
| | Female | 0.012± 0.002 | 0.008± 0.004 | 0.010 | | | |
| | cv% | 35.41 | 110.11 | | | | |
| | Overall (strain) | 0.015 | 0.010 | | | | |
| After 72h | Male | 0.008± 0.005 | 0.002± 0.001 | 0.005[b] | NS | 0.0500 | NS |
| | cv% | 154.92 | 154.20 | | | | |
| | Female | 0.007± 0.004 | 0.016± 0.007 | 0.011[a] | | | |
| | cv% | 143.46 | 110.93 | | | | |
| | Overall (strain) | 0.007 | 0.009 | | | | |

a,b Means with different superscripts within the same column are significantly different ($p \leq 0.05$). S=Strain, X = Sex, NS= non-significant means.

**Table (4):**Means and (±SE) of blood Lipids profile as affected by strain, sex & interaction

| Item | Sex | Strain | | Overall Strain | Prob. | | |
|---|---|---|---|---|---|---|---|
| | | Ross | Cobb | | S | X | S*X |
| **Total Cholesterol mg/dl** | Male | 177.14±5.27 | 165.23±2.19 | 171.19 | NS | NS | NS |
| | cv% | 7.50 | 3.24 | | | | |
| | Female | 165.24±7.63 | 167.86 ±2.27 | 166.55 | | | |
| | cv% | 11.31 | 3.32 | | | | |
| | Overall (strain) | 171.19 | 166.55 | | | | |
| **HDL-Cholesterol mg/dl** | Male | 60.47 ±2.78 | 47.55 ±0.68 | 54.01 | 0.0035 | NS | 0.0453 |
| | cv% | 11.26 | 3.51 | | | | |
| | Female | 59.37±1.15 | 56.57 ±3.60 | 57.97 | | | |
| | cv% | 4.75 | 15.60 | | | | |
| | Overall (strain) | 59.92 [a] | 52.06 [b] | | | | |
| **LDL-Cholesterol mg/dl** | Male | 83.88±3.52 | 65.6 ±3.13 | 74.74 | NS | NS | 0.0006 |
| | cv% | 10.29 | 11.71 | | | | |
| | Female | 69.57±3.59 | 78.58 ±3.17 | 74.08 | | | |
| | cv% | 14.11 | 9.90 | | | | |
| | Overall (strain) | 76.74 | 72.09 | | | | |
| **Triglycerides mg/dl** | Male | 84.44 ±6.24 | 80.96 ±3.20 | 82.70 [b] | NS | 0.0389 | NS |
| | cv% | 18.11 | 9.70 | | | | |
| | Female | 92.95 ±3.36 | 91.98 ±4.18 | 92.46 [a] | | | |
| | cv% | 8.86 | 11.12 | | | | |
| | Overall (strain) | 88.7 | 86.47 | | | | |
| **Total lipids mg/dl** | Male | 759.52±7.24 | 609.52±73.01 | 684.53 | 0.0050 | NS | NS |
| | cv% | 1.48 | 29.34 | | | | |
| | Female | 754.67±30.90 | 630.95±34.90 | 692.86 | | | |
| | cv% | 10.03 | 13.55 | | | | |
| | Overall (strain) | 757.14 [a] | 620.24 [b] | | | | |

a,b Means with different superscripts within the same column are significantly different ($p \leq 0.05$). S =Strain, X = Sex, NS= non-significant means

**Table (5):**Means and (±SE) of blood Calcium and Phosphorus as affected by strain, sex & interaction

| Item | Sex | Strain | | Overall Strain | Prob. | | |
|---|---|---|---|---|---|---|---|
| | | Ross | Cobb | | S | X | S*X |
| Calcium mg/dl | Male<br>cv% | 8.52 ± 0.22<br>4.50 | 9.0 ±0.32<br>6.10 | 8.76 | NS | NS | NS |
| | Female<br>cv% | 8.99 ± 0.32<br>6.19 | 8.87 ±0.44<br>8.65 | 8.93 | | | |
| | Overall (strain) | 8.76 | 8.94 | | | | |
| Phosphorus mg/dl | Male<br>cv% | 3.6 ± 0.23<br>11.21 | 4.36 ±0.06<br>2.23 | 3.98 [b] | <0.0001 | 0.0012 | 0.0167 |
| | Female<br>cv% | 4.14 ± 0.11<br>4.49 | 4.45 ±0.03<br>1.06 | 4.30 [a] | | | |
| | Overall (strain) | 3.87 [b] | 4.41 [a] | | | | |

a, b Means with different superscripts within the same column are significantly different ($p \leq 0.05$). S =Strain, X = sex, NS= non-significant means

**Table (6) :**Means and (±SE) of Blood Protien profile as affected by strain, sex and interaction

| Item | Sex | Strain | | Overall Strain | Prob. | | |
|---|---|---|---|---|---|---|---|
| | | Ross | Cobb | | S | X | S*X |
| Albumin g/dl | Male<br>cv% | 2.96 ± 0.08<br>4.47 | 2.88 ±0.12<br>7.02 | 2.92 | 0.0306 | NS | NS |
| | Female<br>cv% | 2.99 ± 0.28<br>16.13 | 2.61 ±0.04<br>2.89 | 2.80 | | | |
| | Overall (strain) | 2.98 [a] | 2.75 [b] | | | | |
| Globulin g/dl | Male<br>cv% | 2.99 ± 0.08<br>4.54 | 3.46 ±0.07<br>7.76 | 3.23 | NS | NS | NS |
| | Female<br>cv% | 3.03 ± 0.14<br>13.56 | 3.41 ±0.14<br>4.39 | 3.22 | | | |
| | Overall (strain) | 3.01 | 3.44 | | | | |
| Total protein g/dl | Male<br>cv% | 5.95 ± 0.24<br>7.1 | 6.34 ±0.2<br>5.54 | 6.15 | NS | NS | NS |
| | Female<br>cv% | 6.02 ± 0.25<br>7.07 | 6.02 ±0.12<br>3.33 | 6.02 | | | |
| | Overall (strain) | 5.99 | 6.18 | | | | |

a, b Means with different superscripts within the same column are significantly different ($p \leq 0.05$). S =Strain, X = Sex, NS= non-significant means

**Table (7):** Means and (±SE) of lymphoid organs % as affected by strain, sex and their interaction

| Trait | Sex | Strain | | Overall (sex) | Prob. | | |
|---|---|---|---|---|---|---|---|
| | | Ross | Cobb | | S | X | S*X |
| Spleen % | Male<br>cv% | 0.09 ±0.04<br>62.85 | 0.04 ±0.01<br>54.71 | 0.06 | NS | NS | NS |
| | Female<br>cv% | 0.08 ±0.03<br>58.82 | 0.04 ±0.02<br>66.14 | 0.05 | | | |
| | Overall (Strain) | 0.08 | 0.04 | | | | |
| Bursa % | Male<br>cv% | 0.08 ±0.01<br>17.68 | 0.10 ±0.02<br>40.82 | 0.09 | NS | NS | NS |
| | Female<br>cv% | 0.06 ±0.04<br>94.28 | 0.09 ±0.03<br>77.74 | 0.08 | | | |
| | Overall (Strain) | 0.07 | 0.09 | | | | |
| Thymus % | Male<br>cv% | 0.64 ±0.06<br>19.14 | 0.62 ±0.10<br>31.16 | 0.63 | NS | NS | NS |
| | Female<br>cv% | 0.80 ±0.10<br>17.68 | 0.82 ±0.08<br>16.71 | 0.81 | | | |
| | Overall (Strain) | 0.69 | 0.71 | | | | |

a, b Means with different superscripts within the same column are significantly different ($p \leq 0.05$). S =Strain, X = Sex, NS= non-significant means.

**Table (8):** Fold Change (Ratio) in Chicken Genes (CD1b /1 & IL4I1/1) _Real time PCR- CT valuesby (Agilent) Mx3000p real time PCR and software Mx-Pro/Excel

| Groups | | HKG Gene "GAPDH/1" CT A | CD1b/1 Gene CT B | IL4I1/1 Gene CT C | $\Delta CT_1$ (A-B) | $\Delta CT_2$ (A-C) | $FOLD_1$ ($2^{-\Delta CT1}$) | ($2^{-\Delta CT1}$) Mean | $FOLD_2$ ($2^{-\Delta CT2}$) | ($2^{-\Delta CT2}$) Mean |
|---|---|---|---|---|---|---|---|---|---|---|
| **Ross (Male)** | **1** | 25.99 | 25.06 | 29.65 | 0.93 | -3.66 | 2.3946 | | 2.0257 | |
| | **2** | 26.67 | 26.58 | 26.28 | 0.09 | 0.39 | 2.9139 | 2.43 | 2.6771 | 2.26 |
| | **3** | 11.58 | 32.03 | 14.18 | -20.45 | -2.6 | 2.0000 | | 2.0743 | |
| **Ross (Female)** | **1** | 25.35 | 16.68 | 10.86 | 8.67 | 14.49 | 2.0002 | | 2.0000 | |
| | **2** | 33.01 | 15.95 | 13.04 | 17.06 | 19.97 | 2.0000 | 2.21 | 2.0000 | 2.00 |
| | **3** | 25.98 | 25.53 | 31.02 | 0.45 | -5.04 | 2.6376 | | 2.0065 | |
| **Cobb (Male)** | **1** | 32.53 | 27.84 | 26.92 | 4.69 | 5.61 | 2.0092 | | 2.0037 | |
| | **2** | 31.12 | 29.84 | 26.77 | 1.28 | 4.35 | 2.2780 | 2.09 | 2.0129 | 2.00 |
| | **3** | 35.27 | 26.71 | 27.08 | 8.56 | 8.19 | 2.0002 | | 2.0003 | |
| **Cobb (Female)** | **1** | 21.58 | 27.77 | 37.02 | -6.19 | -15.44 | 2.0020 | | 2.0000 | |
| | **2** | 24.52 | 21.27 | 24.21 | 3.25 | 0.31 | 2.0388 | 2.07 | 2.7334 | 2.30 |
| | **3** | 22.37 | 20.59 | 24.18 | 1.78 | -1.81 | 2.1686 | | 2.1637 | |

HKG= House Keeping Gene, GAPDH= GlycerAldehyde-3-Phosphate DeHydrogenase, CD1b/1 = gene encodes a member of the CD1 family, IL4I1/1 = Interleukin 4-induced gene 1, ΔCT= CT(a target gene)−CT(a reference gene)

**Table (9):** Fold Change average in (CD1b /1 & IL4I1/1) Genes to studied groups

| $\Sigma$ fold$_1$ ($2^{-\Delta CT1}$) | $\Sigma$ fold$_2$ ($2^{-\Delta CT2}$) | Average CD1b/1 Gene CT | Average IL4I1/1 Gene CT | Fold change CD1b /1 Gene $\Sigma$ fold$_1$($2^{-\Delta CT1}$)/ Average CD1b/1Gene CT | Fold change IL4I1/1 Gene $\Sigma$ fold$_2$($2^{\Delta CT2}$)/ Average IL4I1/1Gene CT |
|---|---|---|---|---|---|
| 26.44 | 25.70 | 24.6542 | 24.2675 | 1.0726 | 1.0589 |

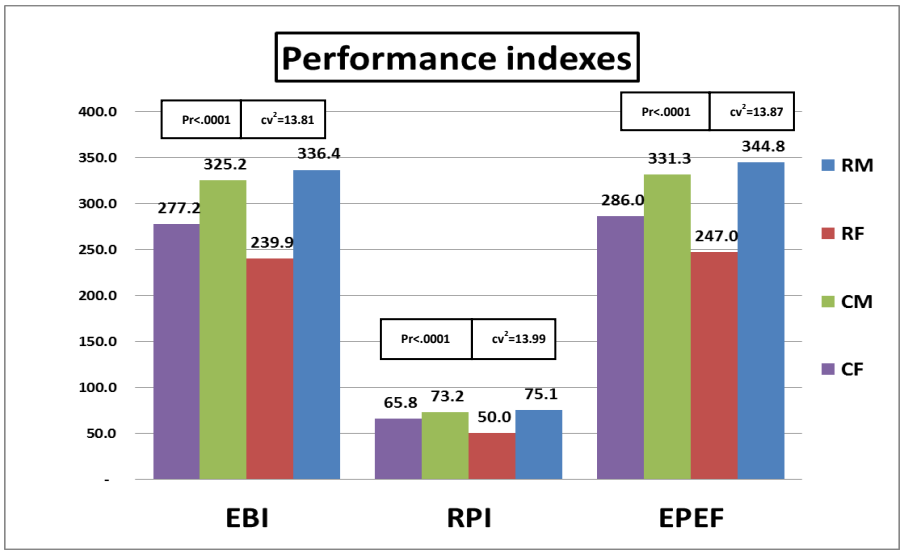


**Figure (1):** Performance Indexes of Broilers: European Broiler Index (EBI), Russian Production Index (RPI) and European Production Efficiency Factor (EPEF) as affected by strain & sex (RM: Ross males, RF: Ross Females, CM: Cobb males and CF: Cobb females)

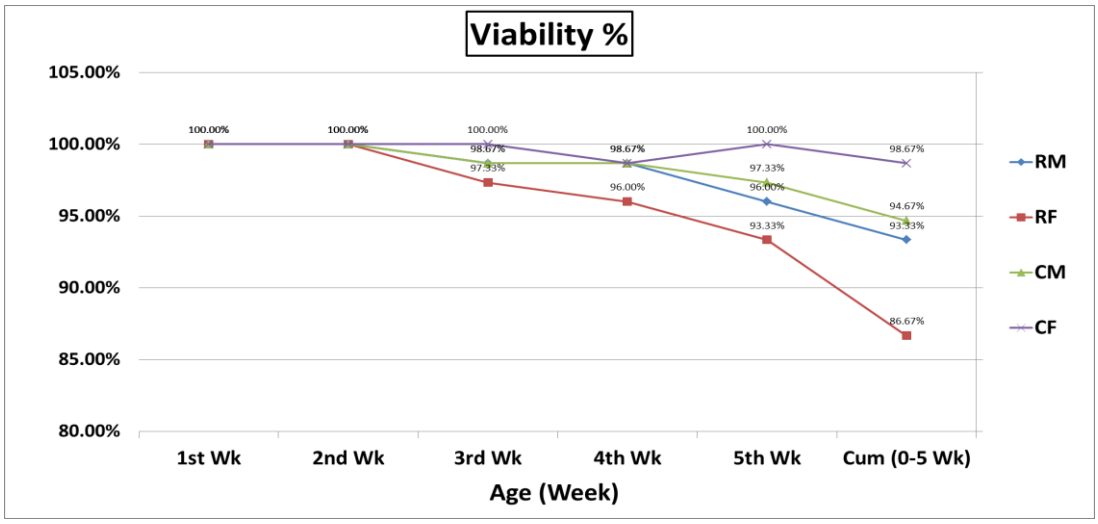


**Figure (2):** Weekly and cumulative viability % as affected by strain and sex(RM: Ross males, RF: Ross Females, CM: Cobb males and CF: Cobb females)

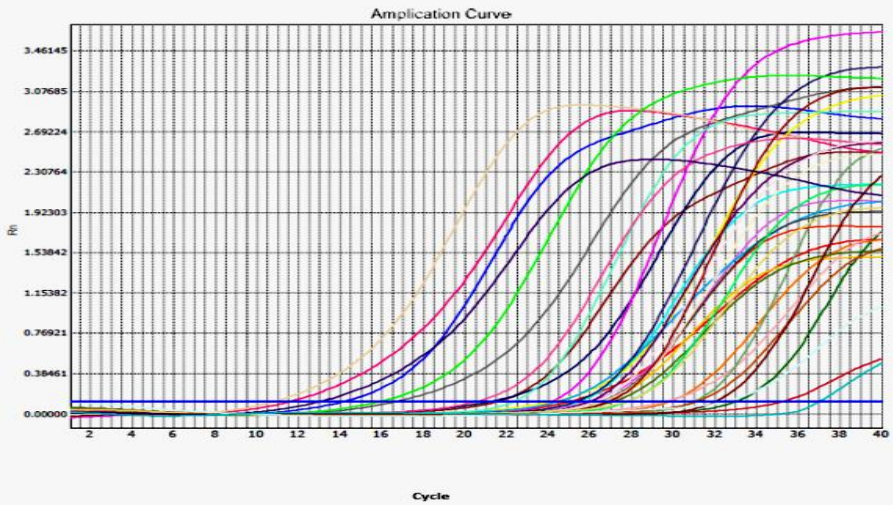


**Figure (3):** Amplification curve of 12 samples from each sex of Ross and Cobb strains.

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**Broiler, Fold Change, CD1b /1, IL4I1/1, Growth, immunity**

## المخلص العربى

# تأثير السلالة والجنس علي معدل النمو والاستجابة المناعية والتعبير الجيني في دجاج اللحم

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**:** يواجه قطاع الدواجن تحديات تتمثل في التذبذب في أسعار المدخلات والمخرجات وكذلك الاحتباس الحراري. يوجد العديد من سلالات دجاج اللحم الأبيض المتاحة بالاضافة الي الإختلاف في الجنس. تختلف السلالات والأجناس إختلافات طفيفة في الاستجابة المناعية وبالتالي في الأداء الانتاجي. تحققت تلك الدراسة من خلال قياس المناعة الخلوية الوسيطة بإستخدام مادة PHA-P، وبعض أدلة الدم وتعبير بعض الجينات المرتبطة بالمناعة (CD1b/1& IL4I1/1) في سلالتين من دجاج اللحم. تم توزيع عدد 600 من الكتاكيت لسلالتي روص308 و كوب500 توزيعاً عشوائياً في تصميم كامل العشوائية الي أربعة مجاميع (ذكور الروص، إناث الروص، ذكور الكوب وإناث الكوب). تم جمع عينات دم عشوائياً عند عمر 35 يوم لتحاليل الدم والتعبير الوراثي. تضمنت النتائج المتحصل عليها تحسن في معامل التحويل الغذائي لذكور سلالة الكوب عند مقارنتها بالمجاميع الأخري. تم التحصل عليمعدل النمو النسبي الأعلي لذكور سلالة الكوب. سجلت ذكور سلالة الروص القيم الأعلي لكل من (دليل دجاج اللحم الأوروبي، دليل الانتاج الروسي، ومعامل كفاءة الانتاج الاوروبي) مقارنة ببقية المجاميع. بالنسبة الي الاستجابة المناعية سجلت سلالة الكوب أعلي رد فعل مناعي للحقن بمادة PHA-P مقارنة بسلالة الروص. سجلت ذكور سلالة الكوب القيم الأعلي لمستوي جلوبيولين الدم مقارنة بالمجاميع الأخري. بخصوص دليل دهون الدم، سجلت ذكور سلالة الكوب وإناث سلالة الروص قيماً أقل لصفة الكوليسترول الكلي في الدم، فيما سجلت سلالة الروص قيماً أعلي معنوياً للدهون الكلية. سجلت سلالة الكوب قيماً أعلي للبروتين الكلي في الدم مقارنة بسلالة الروص. سجلت سلالة الكوب مستوي أعلي من الفوسفور في الدم مقارنة بسلالة الروص. فيما يخص دراسة التحليل الوراثي، وجد أن التعبير الجيني لجين CD1b/1 كان أعلي نسبياً في ذكور سلالة الروص ثم إناث الروص مقارنة ببقية المجاميع، فيما سجل التعبير الجيني لجين IL4I1/1 قيماً أعلي في ذكور سلالة الروص وإناث الكوب عن غيرهم. مضمون النتائج يقترح أن ذكور سلالة الروص يمتلك استجابة مناعية أفضل من غيره من المجاميع، فيما أثبتت الدراسة أنالذكور في كل من السلالتين أكفأ في أداء النمو مقارنة بالإناث.

الكلمات الدالة: دجاج لحم، Fold Change، CD1b ، IL4I1 ، نمو ، مناعة