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Carcass Characteristics and immunocompetence Parameters of Four Commercial Broiler Strain Chickens under Summer Season of Egypt

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Abstract: Selection for faster growth rate is accompanied by changes in the humoral and cell-mediated immunity that may potentially affect the overall immune response. The goal of the present study was to compare the carcass characteristics and immune response of four modern broiler strains. Four different genetic lines of meat-type chicks (125 Avian, 125 Arbor Acres, 125 Cobb and 125 Hubbard) were reared under similar managerial, environmental and hygienic conditions during summer season of Egypt. The high and low ambient temperatures recorded during experimental period were 32.7 and 27.8°C, respectively. The present results revealed that the Cobb and Avian broiler chicks had significantly heaviest marketing body weight compared to remaining strains. The Arbor Acres strain recorded significantly lowest breast muscle percentage compared to other strains. With respect to Cutaneous Basophilic Hypersensitivity (CBH) response, it could be observed that the Cobb strain had a greater dermal swelling response to Phytohemagglutinin-P (PHA-P) followed by Hubbard one when compared to other strains at 24 and 48 h post injection. The Hubbard strain exhibited greater bursa and spleen (as a percentage of live body weight) compared to the Avian ones. The mortality rate of Arbor Acres strain was the highest than those of other broiler strains. We concluded that some parameters of immunocompetence could be considered as a selection criterion when selecting for productive performance under high ambient temperatures.

Key words: Broiler strains, carcass characteristics, immunocompetence

INTRODUCTION

The genetic selection of poultry for superior growth rate has arguably been the primary method for increasing productivity. However, many studies have been shown that such selection may be coincidentally accompanied by decreased resistance to diseases or changes in immunological response (Li *et al*., 2001; Fathi *et al*., 2003; Huff *et al*., 2005). Cheema *et al*. (2007) found that genetic selection for improved broiler performance resulted in decreased antibody response and increased cell-mediated and inflammatory response. Also, the phagocytic potential of chicken macrophages is decreased during heat exposure (Miller and Qureshi, 1992). Guo *et al*. (1998) reported that high temperature resulted in restraint of the development of immune organs of broilers. Vaccination programs alone cannot cope adequately with infectious diseases. A combination of vaccination and genetic resistance is essential to maximize the protection from diseases. Phytohemagglutinin is a lectin; mixture of four subunits isolated from Phaseolus Vulgaris (red kidney bean), its seeds rich with proteins and glycoprotein and is considered (PHA-P) a good in vivo measure T-lymphocyte function (Qureshi *et al*., 1997). Lymphoid organ weights are easily measured and reflect the body's ability to provide lymphoid cells during an immune response.

Primary and secondary lymphoid organs provide the site for maturation lymphocytes and for the interaction between lymphocytes and antigens. The bursa, thymus and spleen are the important lymphoid organs involved in the development and differentiation of T or B lymphocytes (Eerola *et al*., 1987; Toivanen *et al*., 1987). Genetic resistance of chickens can be improved through selection for immunocompetence. Consequently, several lines of chickens have been developed for humoral or cell-mediated immune response. Developing lines against specific antigens are the most popular and frequent approach of selection to improve the immune response under different environmental conditions and in turn to increase disease resistance. Therefore, the goal of the current study was to evaluate the carcass characteristics and immunocompetence measurements of some broiler chick strains during summer season of Egypt.

MATERIALS AND METHODS

This experiment was carried out at Poultry Breeding Farm, Poultry Production Department, Faculty of Agriculture, Ain Shams University. At 22, July, 2009, four genetic lines of broiler chicks (125 Arbor Acres, 125 Avian, 125 Hubbard and 125 Cobb) obtained from a Miser El Arabia hatchery were used in this experiment. The chicks were reared under similar managerial,

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environmental and hygienic conditions. Upon arrival, the chicks of each strain were spray paint identified to their wing bows. They were brooded in electrical brooding batteries up to 2 weeks of age. Fresh straw was used as a bedding material over a concrete floor. The feed and water were supplied *ad libitum*. They were fed a corn-soybean meal commercial diet containing 21% crude protein and 2900 kcal ME/kg diet. The high and low ambient temperatures recorded during the experimental period were 32.7 and 27.8°C, respectively.

Measurements and observations

Carcass characteristics: At 42 days of age, ten chicks from each strain were slaughtered for carcass evaluation. They were slaughtered after weighing. Then they were reweighed after bleeding to calculate blood weight by difference. Feathers were manually plucked up after scalding at hot water and then the birds were reweighed to calculate feathers weight by difference. Head, shank and foot were weighed after removing. The birds were eviscerated by removing the viscera. The giblets (gizzard, liver and heart) were dissected from the viscera and the gizzard was cut, open and cleaned from its contents. The carcass, thigh, drumstick and breast muscles minor and major were weighed. Each organ or muscle was expressed as a proportion of the live body weight.

Immunocompontence measurements

Phytohemagglutinin injection (*In vivo* cell-mediated immunity assay): Response induced in vivo by mitogen was evaluated by injection of Phytohemagglutinin-P (PHA-P) into the toe web between the second and the third digits of male chicks. Twenty chicks from each strain at 4 weeks of age were used. Each chick was intradermally injected in the toe web of the left foot with 100 µg PHA-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 h after PHA-P injection. The toe-web swelling was calculated as the difference between the thickness of the toe web before and after injection.

Heterophils/lymphocytes ratio: At 42 days of age, blood sample was obtained Heterophil (H) and Lymphocyte (L) enumeration based on the procedures of Gross and Siegel (1983). Briefly, one drop of blood being smeared on each of glass slides. The smears were stained using Wright's stain. Three hundred leukocytes, including granular (heterophils) and nongranular (lymphocytes) ones, were counted on one slide of each bird and the heterophil to lymphocyte ratio was calculated.

Relative lymphoid organs weight: After completion of phytohemagglutinin assay, the same chicks were weighed and slaughtered. The bursa of Fabricius, spleen, thymus (all lobes from left side of the neck) were removed and weighed to the nearest milligram.

Statistical analysis: Data were subjected to a one-way analysis of variance with strain effect using the General Linear Model (GLM) procedure of SAS User's Guide, (2001). When significant differences among means were found, means were separated using Duncan's multiple range tests.

RESULTS AND DISCUSSION

Effect of strain on body weight and edible meat parts weight of broiler chicks is summarized in Table 1. The present result showed that the Avian and Cobb broiler chicks were heaviest body weight compared to remaining strains, but the difference did not statistically significant. With respect to absolute and relative dressing weight, it could be observed that the Avian strain recorded the heaviest dressing weight compared to other strain. However, the Cobb strain recorded the lowest dressing percentage compared to remaining strains. There was no significant difference among strains for absolute and relative liver weight. Inversely, the weight and percentage of gizzard significantly affected by strain, whereas Arbor Acres broiler chicks had significantly higher absolute and relative gizzard weight compared to Cobb and Hubbard ones. The Avian strain was intermediated. Concerning to heart weight and percentage, our results indicated that there was no significant difference among strains for absolute heart weight. Opposite trend was noticed for relative heart weight, whereas the Cobb broiler chicks had significantly higher relative heart weight compared to Avian ones. The Arbor Acres and Hubbard strains were intermediated. The giblets weight and percentage were significantly affected by strain. The Arbor Acres broiler chicks were significantly higher absolute and relative giblets weight compared to other strains. Finally, the edible meat parts (weight and %) did not significantly affected by strain.

Absolute and relative breast, thigh and drumstick muscles weight of broiler chicks as affected by strain are presented in Table 2. There was no significant difference among strains for absolute and relative major pectorals muscle weight. In contrast, the minor pectorals muscle (weight and %) significantly affected by strain, where the Avian and Cobb broiler chicks were significantly higher absolute and relative minor pectorals muscle weight compared to remaining strains. Generally, the breast muscles (weight and %) of Arbor Acres strain had significantly lowest than those of other strains. With respect to thigh muscle weight, it could be observed that there was no significant difference among strains for absolute thigh muscle weight. Conversely, the Arbor Acres strain had significantly heavier thigh muscle percentage compared to Avian ones. The Cobb and

Table 1: Body weight and edible meat parts weight of Arbor Acres, Avian, Cobb and Hubbard broiler chick strains

	Strain				
Trait	Arbor Acres	Avian	Cobb	Hubbard	Prob.
Live body weight (g)	2376.20±68.13	2498.25±83.57	2434.63±98.46	2391.38±67.96	NS
Dressing (g)	1760.67±52.85	1852.63±68.02	1793.31±75.61	1773.69±57.20	NS
Dressing (%)	74.10±0.78	74.11±0.75	73.65±0.64	74.07±0.56	NS
Liver (g)	49.92±1.60	48.54±1.89	45.80±2.50	49.35±2.64	NS
Liver (%)	2.06±0.05	1.95±.07	1.90±0.11	2.05±0.07	NS
Gizzard (g)	31.38^{a}±0.81	29.10^{ab}±1.01	26.11^{c}±0.96	27.99b^{c}±0.75	0.001
Gizzard (%)	1.33^{a}±0.04	1.17b^{c}±0.04	1.08^{c}±0.03	1.22^{b}±0.05	0.001
Heart (g)	5.59±0.29	5.53±0.19	5.90±0.22	6.01±0.29	NS
Heart (%)	0.24^{ab}±0.01	022^{b}±0.01	0.25^{a}±0.01	0.24^{ab}±0.01	0.05
Giblets (g)	85.89^{a}±2.29	78.32^{ab}±5.53	77.82^{ab}±2.81	72.89^{b}±4.90	0.05
Giblets (%)	3.63^{a}±0.07	3.15^{b}±0.22	3.23^{ab}±0.11	3.05^{b}±0.18	0.05
Edible meat parts (g)	1846.56±54.46	1930.95±69.59	1871.13±77.53	1846.58±59.55	NS
Edible meat parts (%)	77.73±0.78	77.26±0.72	76.88±0.68	77.12±0.58	NS

^{a,b,c}Means within the same raw with different letters are significantly differed.
Giblets = liver + heart + gizzard, Edible meat parts = dressing + giblets

Table 2: Breast, thigh and drumstick muscles weight of Arbor Acres, Avian, Cobb and Hubbard broiler chick strains

	Strain				
Trait	Arbor Acres	Avian	Cobb	Hubbard	Prob.
Major pectorals muscle (g)	324.57±14.29	360.93±13.86	340.80±14.09	348.38±12.80	NS
Major pectorals muscle (%)	13.96±0.77	14.82±0.75	14.36±0.32	14.59±0.40	NS
Minor pectorals muscle (g)	74.27^{b}±3.44	86.14^{a}±2.44	87.75^{a}±3.82	82.57^{b}±3.32	0.05
Minor pectorals muscle (%)	3.16^{b}±0.18	3.70^{a}±0.12	3.77^{a}±0.15	3.53^{b}±0.12	0.05
Breast muscle (g)	387.85^{b}±19.62	448.63^{a}±23.98	432.80^{a}±14.63	439.38^{a}±23.23	0.01
Breast muscle (%)	16.20^{b}±0.94	18.70^{a}±1.26	18.44^{a}±0.34	18.41^{a}±0.82	0.01
Thigh muscle (g)	143.40±6.38	152.94±10.85	136.69±6.02	136.56±4.18	NS
Thigh muscle (%)	6.02^{a}±0.16	5.28^{b}±0.37	5.64^{ab}±0.17	5.79^{ab}±0.09	0.01
Drumstick muscle (g)	108.33^{b}±3.47	131.47^{a}±8.21	114.13^{b}±5.74	111.94^{b}±4.55	0.01
Drumstick muscle (%)	4.56±0.08	4.62±0.12	4.67±0.07	4.68±0.12	NS

^{a,b}Means within the same raw with different letters are significantly differed

Hubbard strains were intermediated. The Avian broiler chicks had significantly heaviest drumstick weight compared to remaining strains. However, there was no significant difference among strains for relative drumstick muscle weight.

Immunocompetence parameters

Cell-mediated immunity (CMI): Cell-mediated immunity of chickens has been examined and demonstrated to be under the influence of genetic origin (Lamont and Smyth, 1984). Data presented in Fig. 1 and 2 showed that the CMI response was found significantly higher in Cobb strain at 24 h post PHA-P injection as compared to Arbor Acres one. However, Avian and Hubbard strains were intermediated. Similar trend was noticed at 48 h post PHA-P injection. Conversely, at 72 h post PHA-P injection, the toe-web swelling for Avian and Hubbard broiler chicks was significantly higher than that of Arbor Acres and Cobb ones. The differences among strains for response to PHA-P injection could be attributed to the lymphoblastogenic response to PHA-P are presumed to be polygenic (Morrow and Abplanalp, 1981). Also, T-cell mediated immune response of chicken has significantly variation among birds of different genetic lineage (Lamont and Smyth, 1984; Cheng and Lamont, 1988). Successful divergent selection of chickens for various T-cell functions suggests that many of these functions are highly heritable and are often negatively correlated with body weight (Yamamoto and Okada, 1990; Afraz *et al*., 1993). There was a good indication that cell-mediated immunity plays an important role in controlling and clearing intracellular bacterium (Kougt *et al*., 1994, 1995). The results reported herein pointed out the Cobb followed by Hubbard and Avian broiler chicks has better immune responders than the Arbor Acres one. Also, selection on cellular responsiveness might add to enhancement of resistance to coccidiosis (Parmentier *et al*., 2001). Therefore, the Cobb strain may be more resistant to coccidiosis than that of remaining strains.

Relative lymphoid organs weight: Bursa of Fabricius size may not necessarily be associated with antibody titers. Yamamoto and Glick (1982) observed in a chicken line selected for small bursa size had higher total and 2-mercaptoethanol-resistant antibody titers in the secondary response compared to the counterparts in the line selected for large bursa size. Ubosi *et al*. (1985) reported that, in ninth generation, high antibody titer had

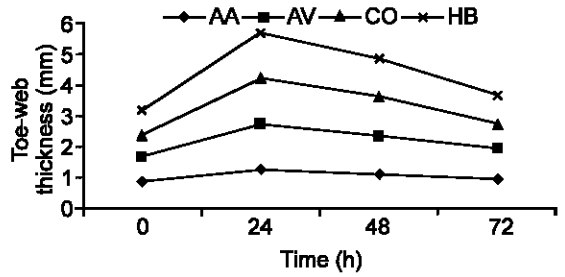

Fig. 1: Toe-web swelling thickness (mm) of Arbor Acres (AA), Avian (AV), Cobb (COB) and Hubbard (HB) broiler strains

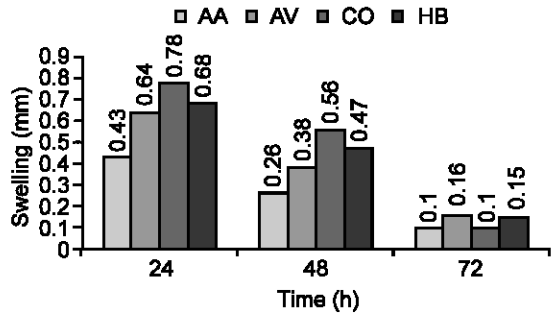

Fig. 2: Toe-web swelling (difference) of Arbor Acres (AA), Avian (AV), Cobb (COB) and Hubbard (HB) broiler strains

smaller thymus and larger bursa than low antibody titer, relative to body weight, but there were no differences in relative spleen weight. Data presented in Table 3 showed that the Hubbard broiler chicks had significantly higher bursa (weight and %) compared to Cobb and Avian ones. However, the Arbor Acres broiler chicks were intermediated. The spleen performs a number of non-immunological functions including filtration of the blood stream (Miller *et al*., 1991). The spleen provides microenvironment, which is needed fro antigens presentation and concentrating them in the white pulps where T and B cell interactions, lead to the formation of antibodies (Williams *et al*., 1991). The present results indicated that the relative spleen weight of Hubbard strain was significantly higher than that of Avian one. However, the Cobb and Arbor Acres broiler chicks were intermediated. The size of the spleen of avian species may be influenced by genotype (Ubosi *et al*., 1985). In the absence of well developed lymph node system in the chicken, the spleen is the major organ involved in immune response to some antigens. With respect to relative thymus weight, the results revealed that there was no significant difference among strains for absolute and relative thymus weight. The immunological function of thymus is to provide a specific environmental essential for T-cells differentiation, which essential for cell-mediated immunity and modulation of immune response (Owen, 1977). It could be concluded that the Hubbard broiler chicks had higher relative lymphoid organs weight followed by Arbor Acres ones compared to Cobb and Avian broiler ones. Though, the Cobb strain had a higher immune response compared to other strains. The previous results suggests that the size of lymphoid organs weight may not associated with higher immune response of chickens. A similar result was observed by Fathi *et al*. (2003) they reported that size bursa and thymus did not affect the cell mediated immune response.

Heterophils/lymphocytes ratio: Data presented in Table 4 showed that the effect of strain on heterophils, lymphocytes count and H/L ratio under summer season of Egypt. It could be observed that the Arbor Acres broiler chicks had significantly higher heterophils percentage compared to remaining strain. Opposite trend was noticed for lymphocytes percentage, whereas the Cobb broiler chicks had significantly higher lymphocytes percentage compared to other strains. The last results indicated that the Cobb broiler chicks were more resistant to heat stress compared to remaining strains. Heterophils increase and lymphocytes decrease when are stressed, so that the ratio between them is an index of response to a stressor (Siegel, 1995). There is a genetic component to heterophils and lymphocyte responses to stressors (Gross and Siegel, 1985) and their ratio has been used as a selection criterion for heat resistance in chickens (Al-Murrani *et al*., 1997). Heterophils have been reported to phagocytosis and digest *Escherichia coli*, *Bacillus megaterium* and digest *Escherichia coil*, *Bacillus megaterium* and *Staphylococcus aureus*. Gross and Siegel (1985) suggests that genetic variation may exist in the immunocompetence of heterophils.

With respect to H/L ratio, the current results indicated that the Cobb broiler chicks had significantly lowest H/L ratio compared to Arbor Acres strain. However, the Avian and Hubbard strains were intermediated. The H/L ratio is a recognized measure of stress in birds (Davison *et al*., 1983; Gross and Siegel, 1983; Maxwell, 1993; Al-Murrani *et al*., 1997, 2002) that has become a valuable tool in stress research especially when combined the convenience and repeatability of automated blood cell count (Post *et al*., 2003). The H/L ratio has been suggested selection criteria for general stress resistance in broiler chickens by Al-Murrani *et al*. (1997) who showed that light-bodied Iraqi fowl had significantly lower H/L ratios compared with a heavy Iraqi broiler line. The broiler line was a mixed-sex population with only 10% males and the male population had significantly higher H/L ratios compared with females, suggesting that the additional stress of higher body weight in males accounted for the increase in H/L ratio (Al-Murrani *et al*., 1997).

Table 3: Absolute and relative lymphoid organs (weight and %) of Arbor Acres, Avian, Cobb and Hubbard strains

	Strain				
Trait	Arbor Acres	Avian	Cobb	Hubbard	Prob.
Bursa (g)	2.12^{ab}±0.15	1.94^{b}±.0.12	1.72^{b}±0.11	2.65^{a}±0.45	0.05
Bursa (%)	0.09^{ab}±0.006	0.08^{b}±0.007	0.08^{b}±0.05	0.11^{a}±0.016	0.05
Spleen (g)	2.82^{ab}±0.18	2.41^{b}±0.22	2.52^{b}±0.15	3.13^{a}±0.23	0.05
Spleen (%)	0.12^{ab}±0.007	0.10^{b}±0.09	0.11^{ab}±0.008	0.13^{a}±0.009	0.05
Thymus (g)	4.48±0.45	3.45±0.35	4.34±0.36	4.37±0.34	NS
Thymus (%)	0.18±0.011	0.18±0.014	0.20±0.145	0.21±0.014	NS

^{a,b}Means within the same raw with different letters are significantly differed

Table 4: Heterophils and lymphocytes count of broiler chicks as affected by strain

	Strain				
Trait	Arbor Acres	Avian	Cobb	Hubbard	Prob.
Heterophils	27.00^{a}±1.79	21.80^{b}±1.17	21.56^{b}±1.04	22.70^{b}±1.14	0.01
Lymphocytes	85.90^{b}±3.19	86.80^{b}±1.77	88.56^{a}±2.33	87.20^{b}±2.31	0.05
H/L ratio	31.76^{a}±2.18	25.31^{b}±1.62	24.32^{c}±0.95	26.16^{b}±1.37	0.001

^{a,b,c}Means within the same raw with different letters are significantly differed

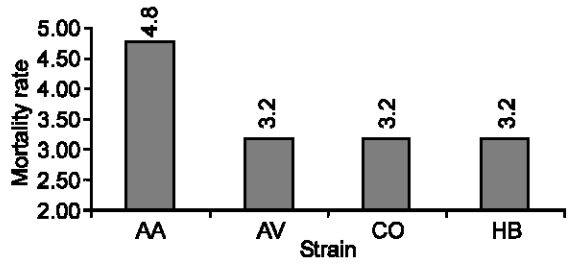

Fig. 3: Mortality rate (0-42 day) of Arbor Acres (AA), Avian (AV), Cobb (CO) and Hubbard (HB) broiler strains

Mortality rate: Date presented in Fig. 3 showed that the mortality rate of Arbor Acres strain was higher than those of other strains, whoever, the mortality rate of the Avian, Cobb and Hubbard strains as the same.

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