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EFFECT OF FEED RESTRICTION AND VITAMIN C SUPPLEMENTATION ON GROWTH PERFORMANCE, CARCASS CHARACTERISTICS AND SOME BLOOD PARAMETERS OF BROILER REARED UNDER HEAT STRESS

A.A. Desoky[1] and Nancy N. Kamel[2]

[1]Department of Animal Production, Faculty of Agriculture, Cairo University, Egypt.

[2]Department of Animal Production, National Research Center, Dokki, Giza, Egypt.

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SUMMARY

Production performance is closely related to feed intake and feed components. Heat stress has a direct effect on feed intake and can impair productivity and immunological responses. The present study was designed to investigate the effect of feed restriction and vitamin C supplementation on broiler performance under heat stress conditions. A total of 180 one-day old Arbor Acres chicks were randomly assigned to four experimental groups with three replicates (15 birds of each). The experimental chicks were fed the basal diet *ad libitum* (Control), fed the basal diet supplemented with 250 mg/kg vitamin C (Vit. C) *ad libitum*, deprived of feed for 8h/day (FR), or received the basal diet supplemented with 250 mg/kg vitamin C with feed deprivation for 8h/day (FR+Vit. C). All the experimental groups were exposed to cyclic environmental heat stress of 33.5±1.5˚C for 8h/day starting from 21 to 42 days of age. The feed withdrawal was synchronized with the period of temperature elevation. Feed intake, body weight gain and feed conversion were measured on 0, 21, 35 and 42 days of the experiment. At the end of the experiment, blood samples were collected for determining the H/L ratio and quantifying some relative plasma constituents. Antibody titers of Newcastle (ND), Infectious Bronchitis (IBD) and Avian Influenza (AID) diseases were quantified after three weeks of immunization. Data revealed that feed restriction caused a significant reduction in feed intake and weight gain of broilers during the first three weeks of life. Vitamin C supplementation improved feed intake, body weight gain and feed conversion during the period from 22 to 35 days. Plasma total protein and albumin increased significantly, while transaminases (liver enzymes) activity and the H/L ratio were reduced significantly due to different treatments when compared to the control. Antibody titers for ND and IBD significantly increased due to the different treatments as compared to the control group. The data revealed that feed restriction under thermo-neutral condition reduces the broiler growth performance. But when birds were subjected to elevated environmental temperature, feed rustication with or without vitamin C supplementation improved the broiler performance, with no effect on carcass characteristics, and produced a substantial improvement in immune response of heat stressed broilers. Vitamin C supplementation at 250 mg/kg can be used to alleviate the negative effects of heat stress on broiler productive and immunological responses.

Keywords: *feed restriction, vitamin C, heat stress, broiler, production performance, immune response*.

INTRODUCTION

Heat stress imposes a tremendous management challenge in tropical and subtropical countries. Reduction in feed intake has a direct negative effect on nutrient availability and subsequently can suppress growth of animals and poultry. Al-Batshan (2002) reported a significant reduction in both feed intake and weight gain of broilers exposed to ambient temperatures of 33±0.5°C. The results of genetic × temperature interaction implied that the fast-growing broilers were more susceptible to heat stress as compared to the slow-growing strains. High environmental temperature (at 26.7°C) lowered broiler productive performance and impaired carcass characteristics (Olanrewaju *et al*., 2010). Moreover, the elevation in ambient temperature to 38±1°C for two different broiler strains for only three hours a day caused a negative impact on oxidative stress and increased lipid peroxidation and heterophils:lymphocytes ratio (H/L) (Altan *et al*., 2003). A reduction in meat quality traits was also reported in cyclic or chronic heat stressed broilers (Akşit *et al*., 2006; Zhang *et al*., 2012; Zeferio *et al*., 2016). Tankson *et al*. (2001) stated that heat stress induced pale and soft exudative meat which is considered a big problem in meat quality. Heat stress can reduce productivity, and may impair the immune response by reducing the antibody production and suppressing the synthesis and function of blood lymphocytes in laying hens and broilers (Mashaly *et al*., 2004; Kamel *et al*., 2017). A reduction in antibody titers to Newcastle disease and Infectious Bural disease viruses (by 18 and 22%, respectively) was observed in broilers exposed to cyclic heat stress at 35±1.1˚C/8h/d from 22 to 42 days of age (Sohail *et al*., 2010). Also, Al-Ghamdi (2008) found a reduction in blood antibodies (IgG and IgM) when Cobb chickens were exposed to 40˚C/3h/d for ten days, from 22 to 32 days of age.

Feed restriction was introduced as a management strategy to reduce the negative effect of heat stress by reducing heat increment generated with nutrient metabolism (Daghir, 2009). Naga Raja Kumari and Narendra Nath (2017) suggested that early feed restriction can be used to mediate the negative effects of heat stress through producing thermo-tolerant birds that are able to maintain high performance under hot environmental condition. Moreover, early feed restriction resulted in a positive effect on broiler immune response which was impaired by heat stress exposure (Khajavi *et al*., 2003). Pan *et al*. (2005) introduced feed restriction as an effective strategy during cold stress to reduce lipid peroxidation through improving enzymatic antioxidant activities in broilers.

Vitamin C, also called ascorbic acid, is presented as a natural antioxidant that can be used to reduce the oxidative stress imposed by heat stress. Supplementation of ascorbic acid at 250 mg/kg feed has been reported to improve feed intake, body weight gain and feed efficiency, and to enhance immune response and antioxidant status of broiler chickens (Khan *et al*., 2012). Abidin and Khatoon (2013) reported that vitamin C ameliorates production and immunity problems induced by heat stress such as suppressing immunity, lowering feed consumption, impairing body weight gain, inducing oxidative stress, increasing rectal temperature and increasing mortality in birds. Al-Ghamdi (2008) suggested that the alteration in plasma vitamin C level can be used as a heat stress indicator in broiler chickens. He found a significant reduction in plasma ascorbic acid in broilers exposed to 40˚C for three hours a day for ten days starting from day 22 of age. McKee *et al*. (1997) reported that ascorbic acid supplementation has the ability to influence body energy stores in favor of improving productivity when feed restriction lead to a reduction in the energy consumption of broilers. Sahin *et al*. (2009) recommended a combination of vitamins C and E supplementation (500 mg of each 1kg of diet) to the diet of quail to improve egg production and heat shock protein synthesis during heat stress.

The present study aimed to investigate the effect of feed restriction and vitamin C supplementation on the productive performance, carcass characteristics, blood constituents and immune response of broiler chickens reared under cyclic heat stress conditions.

MATERIALS AND METHODS

Experimental design:

A total of 180 Arbor Acres broiler chicks at one-day old were divided to four experimental groups and three replicates (15 chicks each) in each group. The experimental birds were offered the basal diet *ad libitum* (Control), fed the basal diet supplemented with 250 mg/kg vitamin C (Vit. C) *ad libitum*, deprived of feeding for 8h a day and then freely fed the basal diet (FR), or given the basal diet supplemented with 250 mg/kg vitamin C with feed withdrawal for 8h a day (FR+Vit. C). Starting from day 21 of the experiment, all groups were subjected to cyclic heat stress (33.5±1.5 °C) for 8h per day. The time of feed withdrawal, for FR and FR+Vit. C groups was synchronized with the time of temperature elevation during the day. The experimental chicks were reared in environmentally controlled floor pens with a light schedule of 23h L: 1h D. The basal diets were formulated to cover the requirement of birds according to NRC (1994), and contained 23.00% CP and 2,986 kcal/kg of ME from hatching to 3 weeks old and 21.24% CP and 3,179 kcal/kg of ME from 3 to 6 weeks of age (Table 1).

Table (1): Composition and calculated analysis of the basal starter and grower diets.

Ingredient	Starter (0-3 Weeks)	Grower (3-6 Weeks)
Yellow corn	54.50	57.50
Soybean meal	33.00	28.00
Corn gluten meal	6.20	6.50
Soybean oil	2.00	4.00
Dicalcium phosphate	1.80	1.60
Calcium carbonate	1.60	1.50
Salt (NaCl)	0.20	0.20
DL-Methionine	0.20	0.20
L-Lysine	0.20	0.20
Premix*	0.30	0.30
Calculated Analysis		
Crude Protein, %	23.00	21.24
ME, Kcal/kg	2,986	3,179
Calcium, %	1.02	0.93
Phosphorus, %	0.50	0.45
Lysine, %	1.29	1.17
Methionine & Cysteine, %	0.95	0.91

**Each 3 Kg of the premix contains: Vitamins: A, 12,000,000 IU; Vit. D_3, 2,000,000 IU; Vit. E, 10,000 mg; Vit. K, 2000 mg; Vit. B1, 1000 mg; Vit. B2, 5000 mg; Vit. B6, 1500 mg; Vit. B12, 10 mg; Biotin, 50 mg; Choline chloride, 250000 mg; Pantothenic acid, 10,000 mg; Nicotinic acid, 30000 mg; Folic acid, 1000 mg; Minerals: Mn, 60,000 mg; Zn, 50000 mg; Fe, 30000 mg; Cu, 10,000 mg; I, 1000 mg; Se, 100 mg and Co, 100 mg.*

ME: Metabolizable energy.

Production and physiological parameters:

Body weights were determined at hatch, before applying the heat treatment (day 21), and at 35 and 42 days of age. Feed consumption was measured from 0 to 21, 22 to 35 and from 36 to 42 days of age. Feed conversion was calculated for each group at different experimental periods. Nine birds were randomly taken at the end of the experiment from each group (3 birds/ replicate) for measuring rectal temperature by inserting a digital thermometer into the cloaca of each chick for one minute.

Broilers were slaughtered at 42 days of age after 8 h of feed withdrawal (3 birds/ replicate). Carcasses were chilled and weighed while the edible organs (gizzard, heart and liver) were separated and weighed. The abdominal fat and total carcass fat (the summation of abdominal, gizzard and neck fats) were separated and weighed. Carcass, giblets, abdominal fat and total carcass fat were expressed as percentages of body weight at slaughter.

At the end of the experiment, blood samples were collected at slaughter in heparinized tubes, from nine birds of each group (3 birds/ replicate), and plasma was separated and stored at -20 ˚C until further analysis. Concentrations of total protein, albumin, cholesterol, triglycerides, and activity of transaminases (AST and ALT) were measured in plasma using kits (Salucea, Haansberg, Netherlands). The heterophils:lymphocytes (H/L) ratio was determined in whole blood using Hema-3 stain (cat# 22-122911, Fisher scientific, USA), according to Zhang *et al*. (2009). Tibia ash percentage determination was performed according to AOAC

International (2005) where tibia pieces were collected, defatted, and ashed at 600°C for 16 h to determine ash percentage. Total P in the samples was determined according to Onyango *et al*. (2003) using a colorimetric method. Briefly, samples were ashed and boiled in acid to dissolve all P. The concentration of P in the supernatant was determined using a kit. Ammonium molybdate was added to the supernatant to form phosphomolybdate, which was then reduced to form a blue phosphomolybdenum complex. Color intensity of the complex was proportional to the P concentration and the latter was determined with a spectrophotometer using absorption at 620 nm. Calcium was determined by flame atomic absorption spectroscopy.

Immune response:

Birds were vaccinated against Newcastle disease (ND) and Infectious Bronchitis disease (IBD) at day 6. The birds were administered with another dose of vaccines against ND and IBD at day 21. At 12 days of age, birds were immunized by vaccines against Avian Influenza disease (AID). Nine blood samples were collected from each group (3 birds/replicate) at the end of the experiment. Commercial ELISA kits were used for detection of antibodies against nucleoprotein and matrix antigen of IBD. The other two antibody titers of ND and AID were determined by hemagglutination-inhibition test as described by Khan *et al*. (2014).

Statistical analysis:

Data were statistically analyzed by one-way analysis of variance for treatment effect, using the general linear model (GLM) procedure of SAS (2006). When the model was significant, Duncan's test was used to separate treatment means at $P \leq 0.05$ (Duncan, 1955).

RESULTS AND DISCUSSION

Productive performance:

The productive performance parameters and body temperature of broiler chickens supplemented with vitamin C and/or subjected to 8 h of feed deprivation under different periods of thermo-neutral and heat stress conditions are presented in Table 2. The results obtained from the first experimental period (1-21 d) show a significant negative effect of feed restriction on body weight gain (BWG) and feed intake for FR and FR+Vit. C groups.

Table (2): Broiler performance under feed restriction (FR) concurrent with or without vitamin C supplementation (Vit. C) and exposed to heat stress.

Performance traits	Control	Vit. C	FR	FR+Vit. C
Initial weight, g	40±0.1	43±0.1	43±0.2	43±0.1
Final weight, kg	2.46 ± 0.04^{c}	2.63 ± 0.04^{a}	2.51 ± 0.04^{bc}	2.62 ± 0.04^{ab}
Weight gain, kg				
1-21d	0.779 ± 0.01^{b}	0.796 ± 0.01^{a}	0.755 ± 0.01^{d}	0.770 ± 0.01^{c}
22-35d	0.940 ± 0.01^{b}	1.06 ± 0.02^{a}	1.04 ± 0.02^{a}	1.07 ± 0.02^{a}
36-42d	0.700±0.02	0.736±0.02	0.678±0.04	0.734±0.04
1-42 d	2.42 ± 0.04^{c}	2.59 ± 0.04^{a}	2.47 ± 0.04^{bc}	2.57 ± 0.04^{ab}
Feed intake, g/bird/d				
1-21d	51.21 ± 0.05^{a}	51.91 ± 0.25^{a}	49.26 ± 0.29^{b}	49.85 ± 0.19^{b}
22-35d	120.19 ± 0.17^{d}	125.21 ± 0.32^{b}	122.13 ± 0.39^{c}	126.86 ± 0.39^{a}
36-42d	215.94 ± 0.20^{a}	208.13 ± 0.36^{b}	195.65 ± 0.40^{d}	205.52 ± 0.23^{c}
Feed conversion				
1-21d	1.38 ± 0.001^{a}	1.37 ± 0.006^{ab}	1.37 ± 0.006^{ab}	1.36 ± 0.006^{b}
22-35d	1.79 ± 0.003^{a}	1.66 ± 0.006^{b}	1.65 ± 0.006^{b}	1.66 ± 0.006^{b}
36-42d	2.16 ± 0.007^{a}	1.98 ± 0.003^{c}	2.02 ± 0.006^{b}	1.96 ± 0.002^{d}
Rectal temperature,˚C	41.47 ± 0.14^{a}	41.43 ± 0.14^{a}	41.07 ± 0.07^{b}	41.04 ± 0.08^{b}

^{a,b,c,d} *Means in the same row with no common superscript differ significantly (P≤0.05).*

It has been reported that feed restriction with time limiting for broiler chickens from day 8 to day 16 of age resulted in a reduction in body weight gain at the end of the restriction period (Demir *et al*., 2004; Butzen *et al*., 2013). Liew *et al*. (2003) reported that feed restriction caused a reduction in body weight of broilers subjected to 36 °C from 2 to 28 days of age, but then growth compensation was observed at 35 days of age. The positive effect of feed restriction on BWG and feed intake in this study began to appear when birds were subjected to high ambient temperature during the period from the day 22 to the day 35 of the experiment compared to the control group. The improvement in BWG of broilers did not continue during the last period from 36 to 42 days of age, which implies an adaptation of the birds in the control group to the cyclic heat stress imposed from day 21 of age. Altan *et al*. (2000) suggested that low-weight broiler strains can be adapted to heat stress, with no negative effect on growth rate, when exposed to early high environmental temperature. Similar reductions in feed intake and body weight were reported in broilers subjected to cyclic heat stress (31±1 or 36±1 ˚C/10h/d) applied from 35 to 42 days of age (Quinteiro-Filho *et al*., 2010). Laganá *et al*. (2007) reported that lower feed intake is the main reason for the impaired broiler performance caused by high environmental temperature. Thus, the increase in feed intake of broilers during the second period of this study was reflected on both positive BWG and feed conversion ratio.

Vitamin C supplementation to non-stressed broilers at the first 21 days of life positively modulate the production performance. Elagib and Omer (2012) reported an improvement in feed intake, weight gain and feed conversion with ascorbic acid supplementation at 150 or 350 mg/kg diet to heat stressed broilers. Chand *et al*. (2014) found that ascorbic acid supplementation increased feed intake, body weight gain and improved feed conversion of broilers reared under cyclic heat stress from day 21 to day 35 of age. Moreover, similar results were reported with negative performance of broilers when they were exposed to cyclic (21-30±2 ˚C) heat stress as compared to their thermo-neutral control at 25±2 ˚C (Abu-Dieyeh, 2006). But when feed restriction was combined with vitamin C supplementation, at the present study an obvious improvement in performance was obtained.

Feed conversion was improved during the first period (1-21 days) in FR+Vit. C group compared to the control. Under heat stress, from day 22 to day 42, feed conversion ratios for FR+Vit C, Vit. C and FR groups were significantly improved. The results of feed conversion reflect the changes in both BWG and feed intake. It was reported that vitamin C supplementation to heat-stressed quail at 500 mg/kg from the seventh day of age improved body weight gain and feed conversion ratio (Mehmet *et al*., 2004).

Rectal temperature decreased significantly by feed restriction with or without vitamin C supplementation. High ambient temperatures have been reported to cause a significant elevation in rectal temperature in six weeks old broilers in a temperature-dependent manner with the gradual increase of ambient temperature from 32 to 38°C (Tan *et al*., 2010). Francis *et al*. (1991) reported that food withdrawal two hours before temperature elevation and throughout the period of high ambient temperature significantly reduced rectal temperature of broilers.

Carcass and tibia bone characteristics:

Carcass characteristics percentages and tibia ash, calcium and phosphorus are presented in Table 3. Carcass, giblets and dressing percentages did not show any differences due to treatments. Meanwhile, both abdominal fat and total fat percentages were significantly decreased in Vit. C, FR and FR+Vit. C groups compared to the control group. The non-significant differences in carcass and giblet percentages can imply a compensatory effect of body weight gain in the feed restricted groups. Afsharmanesh *et al*. (2016) stated that birds subjected to feed restriction achieved growth compensation and were able to attain normal market body weight at 42 days of age. Zhan *et al*. (2007) reported a decrease in abdominal fat in broilers that were deprived of feed for 4 h per day from hatching to 21 days of age. They suggested that early feed restriction might have induced metabolic programming in chicks leading to changes in carcass composition. Zeferino *et al*. (2016) found no interaction effects between ambient temperature and vitamins C and E supplementation to heat stressed broilers on carcass or giblet percentages.

Tibia calcium percentage increased significantly in the FR and FR+Vit. C groups, suggesting a shift in calcium metabolism in feed restricted groups. Meanwhile, tibia ash and tibia phosphorus percentages did not differ due to treatments compared to the control.

Table (3): Carcass and tibia bone characteristics % of broiler chickens subjected to feed restriction (FR) concurrent with or without vitamin C (Vit. C) and exposed to heat stress.

Characteristics %	Control	Vit. C	FR	FR+Vit. C
Carcass	73.49±0.07	73.52±0.06	73.62±0.08	73.68±0.05
Giblets	4.62±0.09	4.84±0.20	4.62±0.09	4.86±0.20
Dressing	78.12±0.13	78.36±0.22	78.24±0.18	78.54±0.22
Abdominal fat	$1.96±0.05^{a}$	$1.64±0.10^{b}$	$1.52±0.11^{b}$	$1.50±0.07^{b}$
Total carcass fat	$8.76±0.24^{a}$	$7.26±0.22^{b}$	$6.52±0.10^{c}$	$6.44±0.10^{c}$
Tibia ash*	52.15±0.79	53.12±0.82	53.32±1.13	53.25±1.00
Tibia Calcium**	$30.16±0.35^{b}$	$30.88±0.40^{ab}$	$32.11±0.74^{a}$	$32.26±0.81^{a}$
Tibia Phosphorus**	16.42±0.21	16.82±0.29	17.24±0.47	17.34±0.55

^{a,b,c} *Means in the same row with no common superscript differ significantly (P≤0.05).*

**Total carcass fat: the summation of abdominal, gizzard and neck fats.*

***Tibia calcium and phosphorus was calculated as a percentage from ash.*

Blood parameters:

Blood parameters, of broiler chickens subjected to feed restriction (FR) and/or supplemented with vitamin C (Vit. C) are presented in Table 4. Plasma total protein and albumin significantly increased with FR and Vit. C supplementation and their combination as compared to the control group. Plasma cholesterol and triglycerides levels did not differ due to the treatments, however, a tendency of reduction was observed. Activity of transaminases (AST and ALT) showed a significant reduction due to the treatments as compared to the control group. Lin *et al*. (2006) reported that acute heat exposure (32 °C for 6 h) of five weeks old broiler chickens induces oxidative stress which causes a serious injury in the liver. They also linked between elevated body temperature and the induction of serious metabolic changes leading to the induction of oxidative stress that negatively affects liver activity. At the present study, a significant decrease in body temperature was noticed (Table 2) in FR and FR+Vit. C groups which can explain the significant reduction in liver enzymes activity (ALT and AST) observed for these groups. The ratio of H/L was significantly reduced in the FR and/or Vit. C supplementation groups compared to the control group. The results showed that both feed restriction and vitamin C supplementation or their combination have positive effect on alleviating the stress imposed by high environmental temperature.

Table (4): Blood parameters of broiler chickens subjected to feed restriction (FR) concurrent with or without vitamin C (Vit. C) and exposed to heat stress.

Blood parameters	Control	Vit. C	FR	FR+Vit. C
Total protein, g/dl	$5.08±0.10^{c}$	$5.75±0.13^{b}$	$5.86±0.14^{ab}$	$6.22±0.14^{a}$
Albumin, g/dl	$2.81±0.11^{b}$	$3.17±0.13^{a}$	$3.22±0.13^{a}$	$3.42±0.11^{a}$
Globulin, g/dl	$2.27±0.19^{b}$	$2.58±0.17^{ab}$	$2.64±0.16^{ab}$	$2.80±0.15^{a}$
Cholesterol, mg/dl	142.17±8.97	128.12±9.15	122.14±9.29	119.21±8.81
Triglycerides, mg/dl	152.24±10.15	138.16±8.03	134.86±8.22	128.14±8.05
ALT, U/l	$22.16±1.17^{a}$	$18.46±1.14^{b}$	$18.68±0.97^{b}$	$17.51±1.08^{b}$
AST, U/l	$42.51±1.36^{a}$	$37.22±1.35^{b}$	$35.40±1.37^{b}$	$35.21±1.30^{b}$
H/L ratio	$0.58±0.01^{a}$	$0.48±0.01^{b}$	$0.46±0.011^{bc}$	$0.44±0.011^{c}$

^{a,b,c} *Means in the same row with no common superscript differ significantly (P≤0.05).*

Immune response:

The antibody titers of different immunized viral diseases are presented in Fig. 1. The antibody titers of ND and IBD significantly increased due to feed restriction and/or vitamin C supplementation. Meanwhile, there was no change in the AID antibody titer due to treatments compared to the control.

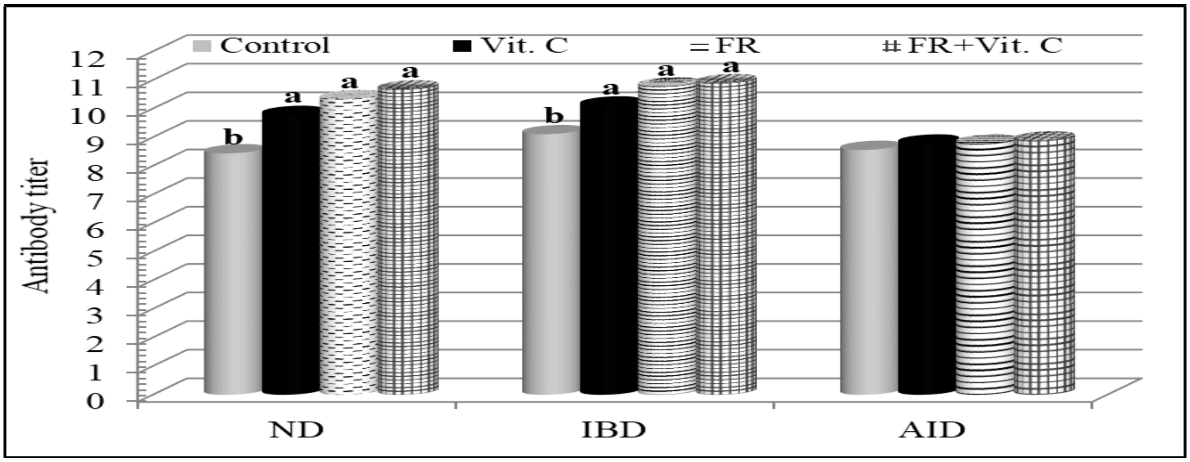

Figure (1): Blood antibody titer of Newcastle (ND), Infectious Bronchitis (IBD) and Avian Influenza (AID) in broilers subjected to feed restriction (FR) concurrent with or without vitamin C (Vit. C) and exposed to heat stress.

Quinteiro-Filho *et al*. (2010) reported a reduction in the relative weights of bursa of Fabricius, thymus, and spleen in broilers reared under cyclic heat stress (31±1 or 36±1°C/10h/day). Ascorbic acid supplementation with different levels (150, 350 and 550 mg/kg) to heat stressed broilers caused a significant direct increase in the antibodies against ND (Elagib and Omer, 2012). Chand *et al*. (2014) also, reported a significant increase in antibody titers of ND and IBD in cyclic heat stressed broilers fed ascorbic acid at 300 mg/kg diet for three weeks starting at 21 days of age. On the other hand, Liew *et al*. (2003) observed a tendency of increasing the antibody titer to infectious bursal disease of broilers reared under cyclic heat stress and subjected to feed restriction as compared to the control group.

CONCLUSION

The present study revealed that feed restriction to broilers reared under thermo-neutral condition reduced the broiler performance. When birds were subjected to elevated environmental temperature and feed rustication with or without vitamin C supplementation, their performance and immune response were improved, with no effect on carcass characteristics. Vitamin C supplementation also had a positive effect on broiler production performance and immune response during heat stress which confirmed the role of vitamin C as anti-stress agent.

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تأثير تحديد الغذاء وإضافة فيتامين ج على الأداء الإنتاجى وصفات الذبيحة وبعض قياسات الدم لدجاج التسمين المربى تحت ظروف الإجهاد الحرارى

عادل عبد المنعم دسوقى[1] و نانسى نبيل كامل[2]

[1] قسم الإنتاج الحيوانى - كلية الزراعة - جامعة القاهرة –مصر.

[2]قسم الإنتاج الحيوانى -المركز القومى للبحوث – الدقى – الجيزة – مصر.

يرتبط الأداء الإنتاجى بصفة وثيقة بكل من المأكول من الغذاء وتركيب الغذاء. وبما أن الإجهاد الحرارى يؤثر بشكل مباشر على المأكول مما قد يعمل على خفض كل من الأداء الإنتاجى ورد الفعل المناعى صممت هذه التجربة لدرسة تأثير تحديد الغذاء وإضافة فيتامين ج على الأداء الإنتاجى لدجاج التسمين المربى تحت ظروف الإجهاد الحرارى. تم استخدام عدد 180 كتكوتاً أربر إيكر عمر يوم والتى تم تقسيمهم عشوائياً على أربع مجموعات تجريبية كل مجموعة مقسمة إلى ثلاثة مكرارات وبكل مكرر 15 كتكوتاً. غذيت الأربع مجموعات على العليقة الأساسية المجموعة الأولى غذيت حتى الشبع (كنترول)، المجموعة الثانية غذيت حتى الشبع مع إضافة 250 ملجم فيتامين لكل كجم من العليقة الأساسية (فيتامين ج)، المجموعة الثالثة غذيت على العليقة الأساسية لمدة 16 ساعة مع سحب الغذاء لمدة 8 ساعات يومياً (تحديد غذاء)، المجموعة الرابعة تم إضافة 250 ملجم فيتامين ج لكل كجم من العليقة الأساسية وغذيت لمدة 16 ساعة وسحب الغذاء لمدة 8 ساعات يومياً (تحديد غذاء+فيتامين ج). تم تعريض كل المجموعات لرفع درجة الحرارة لمدة 8 ساعات / يوم لتصل إلى 33.5 ±1.5 درجة مئوية إبتداً من اليوم 21 من عمر الكتاكيت وحتى اليوم 42 من عمر الطيور. تزامنت مدة سحب الغذاء فى المجموعتان الثالثة والرابعة بفترة رفع درجة الحرارة. تم تسجيل كل من كمية الغذاء المأكول ومعدل الزيادة فى وزن الجسم وكفاءة التحويل الغذائى وفى نهاية التجربة تم أخذ عينات دم لتقدير مكونات البلازما كما تم أيضاً تقدير كمية الأجسام المناعية الخاصة بمرض النيوكاسل والتهاب الشعب الهوائية المعدى وانفلونزا الطيور بعد ثلاثة اسابيع من التحصين. أظهرت النتائج أن تحديد الغذاء عمل على خفض المأكول بشكل معنوى خلال الثلاثة اسابيع الأولى من العمر ولكن لوحظ تحول عكسى عندما تم تعريض هذه الكتاكيت لإرتفاع درجات الحرارة. إضافة فيتامين ج عمل على تحسين كل من الغذاء المأكول ومعدل النمو وكفاءة التحويل خلال الفترة من 22 إلى 35 يوماً من العمر. أرتفعت نسبة البروتينات الكلية والألبيومين كما أنخفض كل من نشاط الإنزيمات الكبدية ونسبة الهتروفيل إلى الليمفوسيت معنوياً نتيجة للمعاملات المختلفة إذا ما قورنت بمجموعة الكنترول. كما لوحظ أيضاً ارتفاع مقياس الأجسام المناعية لكل من مرض النيوكسل والتهاب الشعب الهوائية المعدى نتيجة لمختلف المعاملات مقارنة بمجموعة الكنترول. ومن هنا يتضح أن تحديد الغذاء تحت ظروف الحرارة الطبيعية يعمل على خفض الأداء الإنتاجى لدجاج التسمين. بينما عند تعرض الكتاكيت للإجهاد الحرارى يعمل تحديد الغذاء سواء مع إضافة فيتامين ج للعليقة أو بدون إضافة على تحسين الأداء الإنتاجى بدون التأثير على مكونات الذبيحة مع أرتفاع ملحوظ فى رد الفعل المناعى لكتاكيت التسمين. كما لوحظ أيضاً أن إضافة فيتامين ج بمعدل 250 ملجم/كجم عليقة يمكن أن يستخدم لتخفيف التأثيرات السلبية للإجهاد الحرارى على كل من الأداء الإنتاجى ورد الفعل المناعى لدجاج التسمين.