INTRODUCTION

Turkeys in modern environments can experience a variety of stressors such as in the form of environmental, pathological, or nutritional. Environmental stressors include extreme or unusual climates. It is known that the stress of high ambient temperature may negatively influence the performance of poultry.

The global environmental temperature is also showing an upward trend. In the poultry industries of the world, huge economic losses occur every year because of mortality and decreased production in relation to high environmental temperatures. High ambient temperatures depressed feed intake, resulting in reduced body weight gain and breast yield in turkeys (Veldkamp et al., 2000).

The effects of climatic changes on turkeys have not received a high level of attention. Because, turkeys are known to be less sensitive to heat stress due to better heat dissipation from their relatively large wattles (Yahav, 1998; Yahav, 1999). In earlier reports showed that turkeys could be reared in environmental temperatures between 10 and 26°C if dietary energy regulated (Albuquerque et al., 1978). Yahav (1999) reported a significant decline in weight gain and feed intake when turkeys raised at 35°C versus 25°C and body temperatures were at the normal levels.

Several methods are available to alleviate the negative effects of high environmental temperature on performance of poultry. Because of the high cost and impracticality of cooling animal buildings, interest in dietary manipulations has increased. Studies have shown that antioxidant nutrient supplementation; especially ascorbic acid or vitamin C (VC) can be used to attenuate the negative effects of environmental stress (Sahin et al., 2003). There has been considerable interest in the possible nutritional role for ascorbic acid on the basis that endogenous synthesis may not be adequate to meet the full needs of poultry at all times or requirements for VC may be increased under certain circumstances as stressful conditions (Whitehead and Keller, 2003). Ascorbic acid supplementation improved performance of heat challenged broiler chickens and lowered corticosterone level in the blood (Pardue et al., 1985a). Thus, substantial attention has been paid to the role of nutritional additives to minimize the effect of heat stress. Dietary VC alleviated the effects of heat stress in poultry (Pardue and Thaxter, 1986).

Ascorbic acid plays an important role in the synthesis of...
steroid hormones. These are responsible for mobilizing the energy needed for various vital functions, among other things, for maintaining body temperature. If there is a VC deficiency corticosteroids are formed inadequately. Moreover, corticosteroids and, indirectly VC, play an important role in immunity processes (Seeman, 1991). One of the hormonal responses to heat stress is an increase in the level of corticosterone in blood, the primary glucocorticoid hormone produced by the avian adrenal gland. Ascorbic acid may influence bone development by mediating the biosynthesis of 1,25-dihydroxycholecalciferol and collagen (Farquharson and Jefferies, 2000; McCormack et al., 2001) and, also, may be involved calcium mobilization in bone (Dorr and Balloun, 1976). It is reported that dietary supplementation of VC improved some bone traits (Lohakare et al., 2004), but this was not found in the other studies (Rowland et al., 1973; Orban et al., 1993; Franchini et al., 1994; McCormack et al., 2001).

Supplementation of VC to broiler diet may alleviate effect of heat stress on the performance of broiler chicks reared under heat stress (Kutlu and Forbes, 1993a; Kutlu, 2001; Çelik and Öztürkcan, 2003). Broiler chicken seems to have a special appetite for VC and tends to consume more diet supplementing VC at high temperature (Kutlu and Forbes, 2000). However, there are some reports that adding VC to poultry diets did not positively affect broiler (Stilborn et al., 1988; Marron et al., 2001; Erdoğan et al., 2005) and turkey performance (Dorr and Balloun, 1976; Değirmencioğlu and Ak, 2003) or decreased live weight of broilers (Njoku, 1986).

Therefore, the present study was conducted to determine the effects of dietary inclusion levels of vitamin C on performance, carcass composition and bone characteristics of male turkey during high summer temperature.

**MATERIALS AND METHODS**

**Diets**

Three experimental diets were formulated to provide a similar nutrient profile with the exception of using three graded levels of vitamin C, namely 0, 150, 300 mg per kg diet. Maize-wheat-soybean based diets were utilized and all were formulated using linear programming to be isoenergetic, isonitrogenic and to contain equal level of dry matter, crude fiber, crude ash, calcium, total phosphorus, sulphur amino acids and lysine. Therefore, the arrangement of treatments was: (1) C, control without any addition, (2) ascorbic acid (L-ascorbic acid, Rovimix® Stay C®35, specifically produced for use as a stabilized source of ascorbic acid in feed Roche, Levent-Istanbul, Turkey) was added at the rate of 150 mg per kg diet, (3) ascorbic acid was added at the rate of 300 mg per kg diet. Fresh feed with VC was mixed at 7 day intervals. Small amounts of the basal diet were first mixed with the respective amounts of vitamin C as a small batch, and then with a larger amount of

| Table 1. The composition of diets at 0 to 18 weeks (%) |
|-------------------------------------------------------|
| Ingredients                                       | 0 to 4 wk | 4 to 8 wk | 8 to12 wk | 12 to 16 wk | 16 to 18 wk |
| Maize                                             | 43.76     | 40.00     | 40.00     | 40.00       | 40.00       |
| Wheat                                             | -         | 9.81      | 21.25     | 29.42       | 36.04       |
| Soybean meal                                      | 51.48     | 45.41     | 33.98     | 25.51       | 18.55       |
| Vegetable oil                                     | 0.18      | 0.95      | 1.34      | 2.00        | 2.78        |
| Vitamin-mineral premix1                            | 0.25      | 0.25      | 0.25      | 0.25        | 0.25        |
| Limestone                                         | 2.04      | 1.72      | 1.49      | 1.32        | 1.16        |
| Mono calcium phosphate                            | 1.85      | 1.45      | 1.18      | 1.08        | 0.87        |
| Coccidiostat2                                     | 0.10      | 0.10      | 0.10      | 0.10        | 0.10        |
| L-lysine                                          | 0.14      | 0.06      | 0.06      | 0.05        | -           |
| DL-methionine                                     | -         | 0.05      | 0.15      | 0.07        | 0.05        |
| NaCl                                              | 0.20      | 0.20      | 0.20      | 0.20        | 0.20        |
| Chemical composition (%)2                         | 90.73     | 90.46     | 90.70     | 90.65       | 90.52       |
| Dry matter                                        | 28.37     | 24.58     | 20.87     | 19.07       | 16.32       |
| Crude protein                                     | 4.08      | 3.40      | 3.14      | 3.35        | 2.64        |
| Crude fiber                                       | 7.78      | 6.85      | 5.37      | 5.72        | 4.94        |
| Crude ash                                         | 2.46      | 3.11      | 3.20      | 3.66        | 3.97        |
| Calcium                                           | 1.24      | 1.04      | 0.88      | 0.78        | 0.66        |
| Available Phosphorus                              | 0.57      | 0.48      | 0.41      | 0.37        | 0.32        |
| Lysine                                            | 1.56      | 1.40      | 1.12      | 0.91        | 0.74        |
| Methionine                                        | 0.46      | 0.41      | 0.39      | 0.34        | 0.27        |
| ME (MJ/kg)                                        | 11.19     | 11.65     | 12.18     | 12.68       | 13.17       |

1 Supplied per kg of the feed: Vitamin A, 15,000 IU; Vitamin D3, 2,000 IU; Vitamin E, 40.0 mg; Vitamin K, 5.0 mg; Vitamin B1 (thiamin), 3.0 mg; Vitamin B2 (riboflavin) 6.0 mg; Vitamin B6, 5.0 mg; Vitamin B12, 0.03 mg; Niacin, 30.0 mg; Biotin, 0.1 mg; Calcium D-pantothenate, 12 mg; Folic acid, 1.0 mg; Coline Chloride, 400 mg; Manganese, 80.0 mg; iron, 35.0 mg; zinc, 50.0 mg; copper, 5.0 mg; iodine, 2.0 mg; cobalt, 0.4 mg; selenium, 0.15 mg.

2 Calcium, available phosphorus, lysine, methionine and metabolizable energy (ME, MJ/kg) contents of feed was calculated according to NRC (1994).
the basal diet until the total amount of the respective diets were homogeneously mixed. The experimental diets used in this study are given in Table 1.

**Experimental design and traits measured**

A total of one hundred twenty day-old male BUT6 turkey chicks were individually weighed, wing banded and distributed into three treatments with 5 replicate pens and 8 chicks per pen. Each floor pen was furnished with wood shavings litter and population density of 3.2 birds/m².

Toms were weighed individually at 0, 4, 8, 12, 16 and 18 weeks of age. Body weight gains were calculated from 0 to 4, 4 to 8, 8 to 12, 12 to 16 and 16 to 18 weeks. Feed and water were offered ad libitum. Lighting was 24 h light from 0 to 3 d and 16 h light and 8 h darkness from 4 to 126 d of age. Total feed intake was measured per pen at 4, 8, 12, 16 and 18 weeks of age. Mortality was recorded daily. Feed intake and feed conversion ratio were adjusted for mortality.

This study was conducted during the months of May through September in Izmir, Turkey. This region is one of the very hot regions of Turkey in summer season. Temperature and humidity of the facility were recorded three times daily at 8:00 h, 15:00 h and 20:00 h.

Thirty toms were sampled randomly for carcass evaluations at 126 d of age and slaughtered. Their feathers were plucked mechanically, eviscerated by hand. Whole carcass, abdominal fat pad (excluding the gizzard fat), liver, empty gizzard and heart weights were recorded individually. Left breast meat without bone (only pectoralis muscles) and thigh portions were separated from carcass and weighed. Individual part yields were obtained as part weight: carcass weight ratio. Cold carcass weight was recorded after carcasses were kept at +4°C for 18 h.

In all, ten breast and thigh samples each group (totally 60 samples) were collected in plastic trays, weighed and stored in an air tight plastic bag in a freezer until samples were required for analysis, when they were homogenized using a blender and analyzed for dry matter, nitrogen, ether extract and crude ash. Dry matter content of feed, breast and thigh samples was determined by oven-drying at 105°C for 18 h. Ether extract content of feed, breast and thigh samples was obtained by the Soxhlet extraction using anhydrous diethyl ether. The Kjeldahl method was used for the analysis of total nitrogen content of feed, breast and thigh samples and crude protein was expressed as nitrogen×6.25 (AOAC, 1980). Crude ash content was determined after heating in a muffle furnace at 550°C for 16 h. The crude fibre content of feed was determined using 12.5% H₂SO₄ and 12.5% NaOH solutions (Nauman and Bassler, 1993).

The pH value of the samples was determined with a pH meter (Hanna Instruments-8413) and measured using a direct probe by thrusting the probe into the breast and thigh. The colors of breast and thigh were measured using a Minolta colorimeter (CM508d) to measure CIE Lab values (L* measures relative lightness, a* relative redness and b* relative yellowness).

The left tibia bones were removed. Bones were cleaned of adheral tissues, then weighed; length and width (at midpoint) were measured with a digital caliper. Bones were frozen at -20°C until analyses. After thawing to room temperature bone breaking strength was determined by Instron Testing Machine and the bones were subjected to test at the midpoint of each bone until they fractured (Norgaard and Nielsen, 1990). The ash content of tibia bone was determined after heating in a muffle furnace at 550°C for 16 h. The bones were ashed at 600°C for 24 h and ash percentage was calculated. At slaughter, right leg was removed from each carcass and tibia was examined for the prevalence of tibial dyschondroplasia (TD) (Edwards and Veltman, 1983).

Left shank length and width were measured with a caliper rule at 4, 8, 12, 16 and 18 weeks of age. Gait score was measured at 126 d of age. Turkeys were classified into 4 different categories by two observers consulting together at 126 d of age; 0: the bird walked normally; 1: the bird able to walk but had an obvious gait defect, 2: the bird walked only when driven 3: the bird did not walk (Yalçın et al., 1998).

**Statistical analysis**

Data were subjected to ANOVA using General Linear Models (SAS, 1996). The model included level of dietary VC content is presented. Pen means served as the experimental unit for statistical analysis. Means were separated using Duncan’s multiple range tests. The results of statistical analysis were shown as mean values and standard error mean (SEM) in tables.

**RESULTS AND DISCUSSION**

Average temperature was 26.1±0.6, 31.5±0.3, and 31.7±0.3°C and average humidity was 50.8±1.2, 38.2±0.9 and 36.6±0.7 (%) respectively. Average livability value was 96.7±2.87 (%) for experiment and there were no treatment differences.

Body weight, body weight gain, feed intake and feed conversion ratio for the period from 0 to 18 weeks are presented in Table 2. Body weight, body weight gain, feed intake and feed conversion ratio were not affected by VC supplementation (p>0.05). However, body weights and body weight gains were numerically higher in toms fed on the 150 or 300 mg per kg of feed VC supplemented diet compared with control at the end of the experiment. No effects (p>0.05) of VC were found for feed intake and feed conversion ratio. However, feed intake was numerically higher in toms fed on the 150 mg per kg of feed VC
supplemented diet than that of toms fed on the 300 mg per kg of feed VC supplemented diet and control. The addition of VC at the rate of 150 mg per kg of feed numerically decreased the feed conversion ratio. Results of the present experiment indicate that the toms fed a diet with 150 or 300 mg per kg of feed VC during 0 to 18 weeks had no differences (p>0.05) in body weight, total feed intake and feed conversion ratio.

Studies with VC in the turkeys are very limited. There have not been consistent reports on the effects of VC on the performance of turkeys or broilers. Present results are in agreement with the finding of some researchers, in contrast the others. These results may be related mainly nutrient composition of the diet, levels of VC or its form and managerial or environmental conditions. Dorr and Balloun (1976) found no difference in performance of turkey poults at 8 and 12 weeks when VC was incorporated at the rate of 3,000 mg per kg diet at normal temperature. Değirmencioğlu and Ak (2003) found that including VC in turkey diets at 0, 50, 100 and 150 ppm did not significantly affect body weight gain, feed intake and feed conversion ratio during 70-154 days of age in autumn season. The studies with broiler chickens showed that 0 to 1000 ppm doses of VC supplementation to the diets did not affect body weight, body weight gain and feed conversion ratio (Pardue et al., 1985b; Stilborn et al., 1988; Marron et al., 2001; Erdoğan et al., 2005). However, Al-Taweil and Kassab (1990) and Lohakare et al. (2005) noted that VC supplementation increased body weight but did not affect feed intake and feed conversion ratio (Lohakare et al., 2005). It is reported that VC did not improve livability in broiler chicks (Pardue et al., 1985b) and quails (Ipek et al., 2007).

Dietary supplementation of VC (150 to 1,000 mg/kg) increased performance traits of broilers under heat stress (Pardue et al., 1985a; Kutlu and Forbes, 1993a, b; Kassim and Norziah, 1995; McKee and Harrison, 1995; McKee et al., 1997; McKee et al., 1997; Sahin et al., 2003a; Lohakare et al., 2005) and in quail (Sahin et al., 2003). On the other hand, the broilers receiving VC with drinking water (500 mg/kg) improved body weight gain and feed conversion ratio (Çelik and Öztürkcan, 2003). Contrary to the results above, Njoku (1986) concluded that VC reduced the body weights of broilers.

None of bone characteristics influenced by dietary VC (p>0.05) (Table 3). Shank width and length at 28, 56, 84, 112, and 126 days of age were not affected by VC levels. Vitamin C levels did not significantly affect weight, length, width and ash content of tibia and tibia strength at 126 days of age. Dorr and Balloun (1976) found that dietary VC did not affect femur mineralization, but femur mass reduced by dietary VC (3,000 mg/kg) in turkey poults. Studies with broilers have shown that VC supplementation to diet did not affect bone properties (Rowland et al., 1973; Orban et al.,

### Table 2. Effects of ascorbic acid levels on body weight (kg), body weight gain (g), feed intake (g) and feed conversion ratio (feed/gain)

| Trait                  | Period (wk) | Dietary ascorbic acid (mg/kg) | p* | SEM** |
|------------------------|-------------|------------------------------|----|-------|
|                        |             | 0    | 150 | 300 |
| Body weight (kg)       | 0           | 0.059| 0.057| 0.058| 0.729| 0.001|
|                        | 4           | 0.850| 0.873| 0.890| 0.482| 0.02 |
|                        | 8           | 3.22 | 3.26 | 3.23 | 0.936| 0.09 |
|                        | 12          | 7.18 | 7.32 | 7.29 | 0.845| 0.17 |
|                        | 16          | 11.17| 11.34| 11.47| 0.556| 0.20 |
|                        | 18          | 13.25| 13.26| 13.54| 0.469| 0.21 |
| Body weight gain (g)   | 0-4         | 28.3 | 29.1 | 29.7 | 0.468| 0.83 |
|                        | 4-8         | 83.9 | 84.8 | 83.2 | 0.896| 2.42 |
|                        | 8-12        | 141.7| 145.2| 143.2| 0.849| 4.26 |
|                        | 12-16       | 143.2| 143.7| 147.0| 0.637| 3.12 |
|                        | 16-18       | 145.8| 147.5| 144.7| 0.968| 7.65 |
|                        | 0-18        | 104.5| 106.9| 107.0| 0.468| 1.55 |
| Feed intake (g)        | 0-4         | 46.1 | 45.4 | 46.1 | 0.911| 1.40 |
|                        | 4-8         | 174.0| 181.8| 178.0| 0.383| 3.84 |
|                        | 8-12        | 318.6| 324.5| 301.3| 0.364| 11.47|
|                        | 12-16       | 457.3| 454.3| 448.5| 0.906| 14.28|
|                        | 16-18       | 423.1| 435.8| 434.2| 0.669| 10.76|
|                        | 0-18        | 283.6| 287.2| 282.8| 0.812| 3.46 |
| Feed conversion ratio  | (feed:gain) | 0-4  | 1.63 | 1.56 | 1.55 | 0.343| 0.04 |
|                        | 4-8         | 2.03 | 2.15 | 2.12 | 0.650| 0.09 |
|                        | 8-12        | 2.32 | 2.18 | 2.16 | 0.506| 0.11 |
|                        | 12-16       | 3.11 | 3.09 | 3.21 | 0.677| 0.10 |
|                        | 16-18       | 6.40 | 6.09 | 6.45 | 0.806| 0.42 |
|                        | 0-18        | 3.10 | 3.01 | 3.10 | 0.812| 0.10 |

* p: probability, ** SEM: pooled standard errors.
However, it is showed that dietary supplementation VC could increase tibia breaking strength (Chee et al., 2005; Lohakare et al., 2005) and ash (Lohakare et al., 2005) in broilers.

In the present study, treatment did not affect walking ability scores of toms at 126 d of age. There were two toms with score 1 and one tom score 3 in control group and one each tom with score 1, score 2, score 3 in toms fed on the 150 mg per kg of feed VC supplemented diet and one tom with score 3 in toms fed on the 300 mg per kg of feed VC supplemented diet but differences were not significant. Interestingly, there was no tom with TD neither in control nor treatments. This should be because of selection and genetic studies have been done on TD. Edwards (1989), Roberson and Edwards (1994) and Leach and Burdette (1985) did not find any effect of dietary VC (100 to 500 ppm) on TD in broilers.

It is generally assumed that the role of VC in bone metabolism is limited to hydroxylation of proline for formation of collagen and bone matrix during the growth phase of bone (Orban et al., 1993). Moreover, Thornton (1968) reported that VC seemed to enhance the reduction in ossification of the epiphyiscal plate, mineralization of new cancellous bone and the reduction in the degrees of calcification of both types. So, this might partially explain why bone properties were not appreciably affected in the present study.

Carcass and breast meat yield, abdominal fat pad, neck, liver, heart, empty gizzard, thigh and wing proportions were not influenced by VC levels (p>0.05) (Table 4). Dietary VC did not affect carcass yield and its parts but in the control group percentage of empty gizzard aimed to be higher than others. In particular decreasing abdominal fat pad with supplemental VC is attracting to attention. These results agreed with Değirmencioğlu and Ak (2003). They found that 0, 50, 100 and 150 ppm VC did not have significant effects on the slaughter weight, carcass and abdominal fat proportion of the turkeys. Lohakare et al. (2005) found that

### Table 3. Effects of ascorbic acid levels on length (cm) and width (mm) of shank and tibia bones, tibia strength (kg-force), weight (g) and ash content (%) of tibia

| Weeks | Dietary ascorbic acid (mg/kg) | p* | SEM** |
|-------|-------------------------------|----|------|
|       | 0 | 150 | 300 |     |     |
| Shank traits |
| Length | 5.95 | 6.01 | 5.91 | 0.802 | 1.02 |
| Width | 7.8 | 7.85 | 8.03 | 0.489 | 0.14 |
| Length | 10.48 | 10.63 | 10.42 | 0.439 | 1.14 |
| Width | 12.3 | 14.0 | 11.9 | 0.530 | 1.43 |
| Length | 14.88 | 17.68 | 14.64 | 0.382 | 1.7 |
| Width | 13.8 | 13.6 | 13.6 | 0.270 | 0.11 |
| Length | 16.97 | 17.37 | 17.34 | 0.280 | 1.98 |
| Width | 15.2 | 16.8 | 14.7 | 0.316 | 0.21 |
| Length | 17.45 | 17.62 | 17.69 | 0.229 | 2.12 |
| Width | 15.8 | 17.4 | 15.5 | 0.339 | 0.26 |
| Tibia traits |
| Length | 23.72 | 23.78 | 24.03 | 0.558 | 2.14 |
| Width | 14.85 | 14.30 | 14.71 | 0.276 | 0.25 |
| Wet weight | 103.44 | 103.67 | 104.72 | 0.883 | 1.93 |
| Breaking strength | 62.9 | 59.1 | 60.7 | 0.903 | 5.97 |
| Crude ash | 36.00 | 35.50 | 37.23 | 0.379 | 0.89 |

* p: probability, ** SEM: pooled standard errors.

### Table 4. Effects of ascorbic acid levels on some carcass traits (%)

| Trait | Dietary ascorbic acid (mg/kg) | p* | SEM** |
|-------|-------------------------------|----|------|
|       | 0 | 150 | 300 |     |     |
| Slaughter weight (kg) | 13.58 | 13.83 | 14.47 | 0.089 | 0.28 |
| Carcass yield | 82.7 | 82.6 | 82.5 | 0.431 | 0.29 |
| Breast meat yield | 13.7 | 13.9 | 14.0 | 0.896 | 0.32 |
| Thigh | 29.5 | 29.0 | 28.7 | 0.592 | 0.56 |
| Neck | 4.1 | 4.3 | 4.2 | 0.619 | 0.16 |
| Liver | 1.3 | 1.4 | 1.3 | 0.583 | 0.06 |
| Heart | 0.38 | 0.38 | 0.38 | 0.981 | 0.02 |
| Empty gizzard | 1.56 | 1.38 | 1.36 | 0.072 | 0.07 |
| Wing | 12.4 | 12.8 | 12.2 | 0.099 | 0.20 |
| Abdominal fat pad | 0.60 | 0.52 | 0.54 | 0.740 | 0.07 |

* p: probability, ** SEM: pooled standard errors.
0, 10, 50, 100 and 200 ppm VC did not have significant effects on abdominal fat and decreased breast weight. Fletcher and Canson (1991) also reported that treatment with VC during broiler rearing (973 mg/L tap water) had no effect on carcass processing yields. However, some studies suggested that supplementing 250 ppm VC to the broiler rations increased carcass weight (Kutlu, 2001; Şahin et al., 2003a; Lohakare et al., 2005), liver, heart, spleen and empty gizzard weight (Şahin et al., 2003a) but decreased abdominal fat pad with 250 or 300 ppm VC (Kafri et al., 1988; Şahin et al., 2003a).

Supplementation of VC to turkey diets did not affect dry matter, crude protein, crude fat and crude ash in thigh and breast meat (p>0.05) (Table 5). Kutlu (2001) find that inclusion of 250 ppm VC in the broiler rations increased carcass weight (Kutlu, 2001; Şahin et al., 2003a; Lohakare et al., 2005), liver, heart, spleen and empty gizzard weight (Şahin et al., 2003a) but decreased abdominal fat pad with 250 or 300 ppm VC (Kafri et al., 1988; Şahin et al., 2003a).

Table 5. Effects of ascorbic acid levels on thigh and breast composition (%)

| Trait | Dietary ascorbic acid (mg/kg) | 0  | 150 | 300 | p* | SEM** |
|-------|------------------------------|----|-----|-----|----|-------|
| Thigh Dry matter | 25.77 | 26.09 | 26.35 | 0.709 | 0.48 |
| Crude protein | 22.91 | 23.26 | 23.60 | 0.704 | 0.56 |
| Crude fat | 1.81 | 1.77 | 1.66 | 0.965 | 0.40 |
| Crude ash | 1.05 | 1.07 | 1.09 | 0.518 | 0.02 |
| Breast Dry matter | 26.87 | 27.79 | 26.71 | 0.330 | 0.53 |
| Crude protein | 23.98 | 24.69 | 23.77 | 0.598 | 0.66 |
| Crude fat | 1.79 | 1.96 | 1.77 | 0.912 | 0.35 |
| Crude ash | 1.11 | 1.14 | 1.17 | 0.398 | 0.03 |

L*: relative lightness, a*: relative redness, b*: relative yellowness.

In conclusion, in the present study, adding VC to tom

There are a lot of literature on vitamin C and heat stress in poultry. However, as indicated that in the paper, the results have been inconsistent. The reported work failed to demonstrate and beneficial effects of vitamin C supplementation in turkeys under hot conditions. There is a possibility that the ambient temperature was not high enough to cause significant changes in performance and carcass characteristics. The benefits of vitamin C supplementation to poultry would be more obvious under higher temperature. Whitehead and Keller (2003) reported that it is difficult to establish the degree of stress experienced by birds under practical conditions; responses to dietary VC have been more variable in poultry.
ration did not affect body weight, body weight gain, feed intake and conversion ratio, carcass, meat and bone properties. This experiment results did not suggest that dietary supplementation with VC had benefit for measured characteristics during hot summer season of turkey pouls. Moreover there were a number of fundamental differences among reports, including the basal diets, genetic stocks used, and length of the experiments. Studies with VC in turkey rations and effectiveness are very limited. Further experiments should need to be conducted to determine whether the effect of VC at different condition in turkeys.

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REFERENCES

Albuquerque, K., A.T. Leighton, J. P. Mason and L. M. Potter. 1978. Effects of environmental temperature, sex, and dietary energy levels on growth performance of Large White Turkey. Poult. Sci. 57:353-362.

AOAC. 1980. Official Methods of Analysis. 13th edn. Association of Official Analytical Chemist. Washington, DC.

Al-Taweel, R. N. and A. Kassab. 1990. Effect of dietary vitamin C on ascites in broiler chicks. Int. J. Vit. Nutr. Res. 60:366-371.

Balnave, D. 2004. Challenges of accurately defining the nutrient requirements of heat-stressed poultry. Poult. Sci. 83:5-14.

Chee, K. M., M. K. Chung, J. H. Choi and Y. K. Chung. 2005. Effects of dietary vitamins C and E on egg shell quality of broiler breeder hens exposed to heat stress. Asian-Aust. J. Anim. Sci. 18:545-551.

Çelik, L. and O. Öztürkcan. 2003. Effects of dietary supplemental L-carnitine and ascorbic acid on performance, carcass composition and plasma L-carnitine concentration of broiler chicks reared under different temperature. Arc. Tier. 57:27-38.

Değirmenciöglu, T. and İ. Ak. 2003. Güz döneminde besiyi alman hindilerde askorbik asit uygulamasının besi performansı ve bazı karkas özelliklerine etkileri. Uludağ Ün. Zir. Fak. Der. 17: 1-8.

Dorr, P. and S. L. Balloun. 1976. Effect of dietary vitamin A, ascorbic acid and their interaction on turkey bone mineralisation. Br. Poult. Sci. 17:581-599.

Edwards, H. M. Jr. and J. R. Jr. Veltmann. 1983. The role of calcium and phosphorus in the etiology of tibial dyschondroplasia in young chicks. J. Nut. 113:1568-1575.

Edwards, H. M. Jr. 1989. Effect of vitamin C, environmental temperature, chlortetracycline, and vitamin D3 on the development of tibial dyschondroplasia in chickens. Poult. Sci. 68:1527-1534.

Erdoğan, Z., S. Erdoğan, T. Aksu and E. Baytok. 2005. The effects of dietary lead exposure and ascorbic acid on performance, lipid peroxidation status and biochemical parameters of broilers. Turk J. Vet. Anim. Sci. 29:1053-1059.

Farquharson, C. and D. Jefferies. 2000. Chondrocytes and longitudinal bone growth: the development of tibial dyschondroplasia tibial dyschondroplasia. Poult. Sci. 79:994-1004.

Fletcher, D. L. and J. A. Cason. 1991. Influence of ascorbic acid on broiler shrink and processing yields. Poult. Sci. 70:2191-2196.

Franchini, A., A. Meluzzi, G Manfreda and C. Tosarelli. 1994. Vitamin C and bone tissue in broiler. Arch. Gefugel. 58:161-165.

Ipek, A., O. Canbolat and A. Karabulut. 2007. The effect of vitamin e and vitamin c on the performance of japanese quails (Coturnix coturnix japonica) reared under heat stress during growth and egg production period. Asian-Aust. J. Anim. Sci. 20:252-256.

Kafri, I., R. W. Rosebrough, J. P. McMurry and N. C. Steele. 1988. Corticosterone implants and supplemental dietary ascorbic acid effects on lipid metabolism in broiler chicks. Poult. Sci. 67:1356-1359.

Kassim, H. and I. Norziha. 1995. Effects of ascorbic acid (vitamin C) supplementation in layer and broiler diets in tropics. Asian-Aust. J. Anim. Sci. 8:607-610.

Kutlu, H. R. and J. M. Forbes. 1993a. Changes in growth and blood parameters in heat stressed broiler chicks in response to dietary ascorbic acid. Livest. Prod. Sci. 36:335-350.

Kutlu, H. R. and J. M. Forbes. 1993b. Self selection of ascorbic acid in coloured foods by heat-stressed broiler chicks. Physiol. Behav. 53:103-110.

Kutlu, H. R. and J. M. Forbes. 2000. Effects of environmental temperature and dietary ascorbic acid on the diurnal feeding pattern of broilers. Turk. J. Vet. Anim. Sci. 24:479-491.

Kutlu, H. R. 2001. Influences of wet feeding and supplementation with ascorbic acid on performance and carcass composition of broiler chicks exposed to a high ambient temperature. Arch. Anim. Nutr. Arch. Tierer. 54:127-139.

Leach, R. M. Jr. and J. H. Burdette. 1985. The influence of ascorbic acid on the occurrence of tibial dyschondroplasia in young broiler chickens. Poult. Sci. 64:1188-1191.

Lohakare, J. D., B. J. Chae and T. W. Hahn. 2004. Effects of feeding methods (water vs. feed) of vitamin C on growth performance and carcass characteristics in broiler chickens. Asian-Aust. J. Anim. Sci. 17:1112-1117.

Lohakare, J. D., M. H. Ryu, T. W. Hahn, J. K. Lee and B. J. Chae. 2005. Effects of supplemental ascorbic acid on the performance and immunity of commercial broilers. J. Appl. Poult. Res. 14:10-19.

Marron, I., M. R. Bedford and K. J. Mccracken. 2001. The effect of adding xylanase, vitamin C and cupper sulphate to wheat based diets on broiler performance. Br. Poult. Sci. 42:493-500.

McCormack, H. A., R. Fleming, L. McTeir and C. C. Whitehead. 2001. Bone development up to 6 weeks of age in feed-restricted broiler breeders fed on diets supplemented with different concentrations of ascorbic acid. Br. Poult. Sci. 42 (Suppl. 1):91-92.

McCurdy, R. D., S. Barbut and M. Quinton. 1996. Seasonal effect on pale soft exudative (PSE) occurrence in young turkey breast meat. Food Res. Int. 29:363-366.

McKee, J. S. and P. C. Harrison. 1995. Effects of supplemental
ascorbic acid on the performance of broiler chickens exposed to multiple concurrent stressors. Poult. Sci. 74:1772-1785.

McKee, J. S., P. C. Harrison and G. L. Riskowski. 1997: Effect of supplemental ascorbic acid on the energy conversion of broiler chicks during heat stress and feed withdrawal. Poult. Sci. 76:1278-1286.

Naumann, C. and R. Bassler. 1993. Methodenbuch, Band III. Die Chemische Untersuchung von Futtermitteln. VDLUFA-Verlag, Darmstadt, Germany.

Njoku, P. C. 1986. Effect of dietary ascorbic acid (vitamin C) supplementation on the performance of broiler chickens in a tropical environment. Anim. Feed Sci. Tech. 16:17-24.

Norgaard-Nielsen, G. 1990. Bone strength of laying hens kept in an alternative system, compared with hens in cages and on deep-litter. Br. Poult. Sci. 31:81-89.

NRC. 1994. National Research Council. Nutrient requirements of turkeys. Nutrient Requirements of Poultry: 9th revised edition. (National Academy Press, Washington, DC), 35-39.

Orban, J. R., D. A. Roland, K. Commins and R. T. Lovell. 1993. Influence of large doses of ascorbic acid on performance, plasma calcium, bone characteristics and eggshell quality in broilers and leghorn hens. Poult. Sci. 72:691-700.

Pardue, S. L., J. P. Thaxter and J. Brake. 1985a. Role of ascorbic acid in chicks exposed to high environmental temperature. J. Appl. Physiol. 58:1511-1516.

Pardue, S. L., J. P. Thaxter and J. Brake. 1985b. Influence of supplemental ascorbic acid on broiler performance following exposure to high environmental temperature. Poult. Sci. 64:1334-1338.

Pardue, S. L. and J. P. Thaxter. 1986. Ascorbic acid in poultry: a review. World Poult. Sci. J. 42:107-123.

Peeters, E., B. Driessen and R. Geers. 2006. Influence of supplemental magnesium, tryptophan, vitamin C, vitamin E, and herbs on stress responses and pork quality. J. Anim. Sci. 84:1827-1838.

Pion, S. J., E. van-Heughten, M. T. See, D. K. Larick and S. Pardue. 2004. Effects of vitamin C supplementation on plasma ascorbic acid and oxalate concentrations and meat quality in swine. J. Anim. Sci. 82:2004-2012.

Roberson, K. D. and H. M. Edwards. 1994. Effects of ascorbic acid and 1,25-dihydroxycholecalciferol on alkaline phosphatase and tibial dyschondroplasia in broiler chickens. Br. Poult. Sci. 35:763-773.

Rowland, J. R. O., D. A. Roland and R. H. Harms. 1973. Ascorbic acid as related to tibia strength in spent hens. Poult. Sci. 52:347-350.

Sahin, K., M. Onderci, N. Sahin, M. F. Gursu and O. Kucuk. 2003. Dietary vitamin C and folic acid supplementation ameliorates the detrimental effects of heat stress in japanese quail. J. Nutr. 133:1882-1886.

Sahin, K., N. Sahin and O. Kucuk. 2003a. Effects of chromium, and ascorbic acid supplementation on growth, carcass traits, serum metabolites, and antioxidant status of broiler chickens reared at a high ambient temperature (32°C). Nutr. Res. 23:225-238.

SAS. 1996. SAS User's Guide: Statistics (Version 7.01 Ed.). SAS Inst., Inc., Cary, N.C. USA.

Seeman, M. 1991. Is vitamin C essential in poultry nutrition? Misset World Poult. 7:17-19.

Stilborn, H. L., G. C. Jr. Harris, W. G. Bottje and P. W. Waldroup. 1988. Ascorbic acid and acetylsalicylic acid (aspirin) in the diet of broilers maintained under heat stress conditions. Poult. Sci. 67:1183-1187.

Thornton, P. A. 1968. Effects of ascorbic acid on the skeletal response of chicks to vitamin D deficiency. Br. J. Nutr. 22:77-82.

Veldkamp, T., R. P. Kwakkel, P. C. M. Ferket, J. Simons, J. P. Noordhuizen and A. Pipjers. 2000. Effects of ambient temperature, arginine-to-lysine ratio, and electrolyte balance on performance, carcass, and blood parameters in commercial male turkeys. Poult. Sci. 79:1608-1616.

Whitehead, C. C. and T. Keller. 2003. An update on ascorbic acid in poultry. World's Poult. Sci. J. 59:161-184.

Yahav, S. 1998. The effect of acute and chronic heat stress on performance and physiological responses of domestic fowl. Trends in Comp. Biochem. Physiol. 5:187-194.

Yahav, S. 1999. The effect of constant and diurnal cyclic temperatures on performance and blood system of young turkeys. J. Therm. Biol. 24:71-78.

Yalçın, S., P. Settar and O. Dicle. 1998. Influence of dietary protein and sex on walking ability and bone parameters of broilers. Br. Poult. Sci. 39:251-256.

Young, J. F., J. Stagestad, S. K. Jensen, A. H. Karlsson and P. Henckel. 2003. Ascorbic acid, α-tocopherol, and oregano supplements reduce stress-induced deterioration of chicken meat quality. Poult. Sci. 82:1343-1351.