Turkish Journal of Veterinary & Animal Sciences

Volume 29 | Number 5 Article 16

1-1-2005

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Turk J Vet Anim Sci
29 (2005) 1185-1189

Research Article

Effects of Vitamin C Supplementation on Egg Production Traits and Eggshell Quality in Japanese Quails (*Coturnix coturnix japonica*) Reared under High Ambient Temperature**

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Received: 17.09.2004

Abstract: This study was carried out to investigate the effects of dietary vitamin C supplementation on some egg production traits and eggshell quality in Japanese quails reared under high ambient temperature. One hundred fifty-eight 11-week-old female Japanese quails were used. The birds were divided into 4 dietary treatment groups according to vitamin C levels as follows: control (basal ration), treatment I (basal ration + 150 ppm vitamin C), treatment II (basal ration + 250 ppm vitamin C) and treatment III (basal ration + 500 ppm vitamin C). The quails were housed for 9 weeks at high ambient temperature (34 ± 2 °C). No statistically significant difference (P > 0.05) among the treatment groups for livability was observed. The mean egg production of the control and treatments I, II and III groups were 83.13%, 82.54%, 83.29% and 86.43%, respectively. Treatment III's average was significantly (P < 0.05) higher than that of the other groups. Vitamin C supplementation had no effect on feed consumption, feed conversion ratio or eggshell thickness. The average egg and eggshell weights (g) of the control and treatments I, II and III groups were 9.77, 9.66, 9.89 and 9.63 g and 0.82, 0.80, 0.83 and 0.80 g, respectively.

In conclusion, adding vitamin C to the quail ration under heat stress had no significant effect on production traits with the exception of egg production in laying Japanese quails.

Key Words: Japanese quails, vitamin C, heat stress, egg production

Yüksek Çevre Sıcaklığında Yetiştirilen Japon Bıldırcınlarında Rasyona Vitamin C İlavesinin Yumurta Verim Özellikleri ve Kabuk Kalitesine Etkisi

Özet: Bu çalışma, yüksek çevre sıcaklığında barındırılan Japon bıldırcınlarında rasyona vitamin C ilavesinin bazı yumurta verim ve kabuk kalite özellikleri üzerine olan etkisini incelemek amacıyla yapılmıştır. Araştırmada 11 haftalık yaştaki 158 adet dişi Japon bıldırcını kullanılmış, hayvanlar kontrol, rasyonlarına eklenen vitamin C miktarlarına göre deneme grubu I (150 ppm vitamin C), deneme grubu II (250 ppm vitamin C) ve deneme grubu III (500 ppm vitamin C) olmak üzere dört gruba ayrılmıştır. Gruplar dokuz hafta boyunca sıcak stresinde tutulmuştur (34 ± 2 °C). Araştırma sonunda, yaşama gücü bakımından gruplar arasında istatistiksel önemde farklılık saptanamamıştır. Yumurta verim ortalamaları; kontrol, deneme I, II ve III gruplarında sırasıyla % 83,13, % 82,54, % 83,29 ve % 86,43 olarak belirlenmiş, deneme III grubu diğer gruplardan istatistik olarak önemli düzeyde farklı bulunmuştur (P < 0,05). Rasyona vitamin C katkısının yem tüketimi, yemden yararlanma oranı ve kabuk kalınlığına etkisi önemsiz olarak saptanmıştır. Ortalama yumurta ağırlığı (g) ve kabuk ağırlığı (g) değerleri kontrol, deneme I, II ve III gruplarında sırasıyla 9,77, 9,66, 9,89 ve 9,63, ve 0,82, 0,80, 0,83 ve 0,80 g olarak belirlenmiştir.

Sonuç olarak; sıcak stresi altında yetiştirilen yumurtlama dönemindeki Japon bıldırcınlarında rasyona vitamin C ilavesinin yumurta verimi hariç, diğer verim özelliklerine yararlı bir etkisi saptanamamıştır.

Anahtar Sözcükler: Japon bıldırcını, vitamin C, sıcak stresi, yumurta verimi

** This project was supported by Adnan Menderes University (No: VTF 02005)

Introduction

Farm animals have known thermal neutral zones that are primarily dependent on the species, the physiological status of the animals, the relative humidity, the velocity of air, and the degree of solar radiation (1). The increase in body temperature due to exposure to ambient temperatures above the thermal comfort zone has a negative impact on bird performance by decreasing livability, feed intake, body weight gain, egg production, weight and shell thickness (2-5). Heat stress may occur at 27 °C and above; therefore the birds start to use more energy to lose the accumulated body heat. The birds increase their respiration rate to increase their evaporative cooling, thus causing heat stress due to aspiration of more ambient humidity via panting (6). High ambient temperature and relative humidity reduce feed consumption, live weight gain, feed efficiency and egg production and corrupt the acid-base balance, causing respiratory alkalosis and increased mortality (7-9).

St-Pierre et al. (10) declared that total annual economic losses to the livestock industry of heat stress are between $1.69 and $2.36 billion; of these losses, $128 to $165 million are in the poultry industry.

Vitamin C is a water-soluble vitamin required by the body to maintain normal metabolic activities, and is synthesized in the body to meet physiological requirements in poultry (6). Generally speaking, it is not a common practice to add vitamin C to poultry rations; however, because of its anti-stress effect, it could be added to maintain egg production and eggshell quality during heat stress (11). Similarly, in another study, Chang et al. (12) concluded that vitamin C supplementation had a positive effect on the livability and performance of poultry. Several studies indicated that dietary vitamin C supplementation has a positive effect on different poultry production traits (13-18). Okan (19) reported that the feed intake, egg production, egg weight and eggshell weight means of 9-week-old quails were 31.33 g/quail per day, 82.69%, 12.10 g and 1.39 g, respectively. Önol et al. (20) documented that the livability, egg production, feed consumption, feed efficiency, egg weight and eggshell weight of 9-17-week-old Japanese quails reared under constant heat stress were 92.42%, 83.8%, 23.15 g, 354 g feed/dozen eggs, 11.4 g and 0.93 g, respectively, while Kecnik and Sykes (21) stated that dietary vitamin C supplementation had no positive effect on poultry production traits.

The purpose of the present study was to determine the effect of dietary vitamin C supplementation on some egg production traits of Japanese quails reared under heat stress.

Materials and Methods

The study was performed in the Adnan Menderes University, Faculty of Veterinary Medicine Poultry Production Unit from June 1 to August 31, 2003. One hundred fifty-eight female Japanese quails (*Coturnix coturnix japonica*) were used. The quails were randomly selected and divided into 4 groups at 9 weeks old and reared for 2 weeks for adaptation until 11 weeks old. The birds were reared in batteries with 5 subcages (40 x 40 x 20 cm). Into each subcage unit was placed 8 birds to provide 200-cm^2 surface areas per bird. The groups were classified according to vitamin C (BASF® Ascorbic acid) levels as follows: control (basal ration), treatment I (basal ration + 150 ppm vitamin C), treatment II (basal ration + 250 ppm vitamin C) and treatment III (basal ration + 500 ppm vitamin C). The basal ration contained 21.4% crude protein, 2850 Kcal/kg metabolizable energy and 3.3% calcium (22).

Water and feed were offered ad libitum throughout the study. The temperature and relative humidity of the room were recorded daily via minimum-maximum thermometers and hygrometers. The room temperature was maintained with a brooder at 34 ± 2 °C.

The data were collected from eleven to nineteen weeks of age with egg production recorded daily during the experiment. For this purpose, eggs were collected at the same time each day, and daily egg numbers were divided by the number of hen-day birds for determining daily egg production (%). The egg and eggshell weights were measured by digital electrical balance. The eggshell thickness was determined by measuring the mean thickness values taken at the air cell, equator and sharp end of the egg using a dial thickness gage (0.01-20 mm). The eggshell thickness data were evaluated in microns (µ). Fifty eggs randomly selected per week for each group (totally 450 eggs for each group) were weighed one by one for the determination of egg weight means; then the eggs were cracked, and the shells were washed, dried and weighed and measured with the eggshell membrane.

The group feeding was carried out throughout the experiment. The feed consumption and feed conversion ratio means were recorded weekly.

The weekly minimum-maximum temperature and relative humidity means of the house during 11-19 weeks of age were 32.5-34.2, 33.0-34.8, 34.0-35.0, 34.0-35.4, 34.1-35.1, 34.5-35.8, 34.0-35.3, 34.1-35.1 and 33.7-34.7 °C and 45.0%, 42.0%, 41.4%, 42.2%, 44.0%, 48.2%, 40.8%, 42.0% and 46.0%, respectively.

Analysis of variance was used to determine differences among the treatment groups in terms of feed consumption and egg production traits. The differences among group means were determined using Duncan's test (23,24). Chi-square analysis was used to determine the livability differences among groups (25).

Results

Egg production, egg weight, eggshell weigth, eggshell thickness, feed consumption and feed conversion ratio means are shown in the table.

Table. Means of investigated production traits and livability.

The highest egg production mean (86.48%) was determined in treatment III. The differences between treatment III and the other groups were statistically significant ($P < 0.05$). The egg weight mean of treatment II was different from that of treatments I and III ($P < 0.01$).

The feed consumption and feed conversion ratio means of all groups were similar. The eggshell weight means of the control, and treatments I, II and III were 0.82, 0.80, 0.83 and 0.80 g, respectively. The differences between treatments I and III, the control and treatment II group means were statistically significant ($P < 0.001$). The eggshell thickness mean differences were not significant ($P > 0.05$).

The general livability of the control, and treatments I, II and III were 94.7%, 97.5%, 100% and 100%, respectively. No statistically significant difference was observed among the groups ($P > 0.05$).

Discussion

The livability of the treatment group was numerically higher than that of the control group. This result is in agreement with the findings of some other studies, which also realized the beneficial effects of vitamin C supplementation in hot conditions (12). On the other hand, livability was higher than that reported by Önol et al. (20) in quails reared under the same conditions.

The egg production mean of treatment III was significantly higher than that of the other groups ($P < 0.05$). The egg production mean of all groups was similar to the means reported by Önol et al. (20) and Okan (19) and within the range 83.88% and 82.69%, but higher than the 68.3% mean reported by Şahin et al. (17).

With respect to 500 ppm dietary vitamin C supplementation, the current study indicated a better egg production performance under high ambient temperature

Table. Means of investigated production traits and livability.

	Control	Treatment I	Treatment II	Treatment III	
	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	$\bar{X} \pm S_{\bar{x}}$	P
Egg production (%)	83.13 ± 1.04 ^{b}	82.54 ± 1.04 ^{b}	83.29 ± 0.92 ^{b}	86.43 ± 0.97 ^{a}	*
Egg weight (g)	9.77 ± 0.057 ^{ab}	9.66 ± 0.050 ^{b}	9.89 ± 0.051 ^{a}	9.63 ± 0.053 ^{b}	**
Feed consumption (g/quail per day)	18.90 ± 0.53	18.89 ± 0.33	20.05 ± 0.38	19.74 ± 0.42	N.S.
Feed conversion ratio (g/dozen egg)	281.55 ± 6.75	275.58 ± 8.35	288.54 ± 7.28	274.95 ± 5.54	N.S.
Eggshell weight (g)	0.82 ± 0.004 ^{a}	0.80 ± 0.003 ^{b}	0.83 ± 0.005 ^{a}	0.80 ± 0.005 ^{b}	***
Eggshell thickness (µ)	204.48 ± 0.87	204.20 ± 0.74	205.76 ± 0.96	202.56 ± 0.90	N.S.
Livability (%)	94.7	97.5	100.0	100.0	N.S.

* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$, N.S. : Non significant
^{a,b}: Mean values within a row with no common superscript differ significantly

and was in agreement with the findings of many other studies (11,13,14,17).

The egg weight means obtained from all groups in the present study were lower than the 11.46 g reported by Önol et al. (20) and the 11.6, 11.4 and 12.3 g declared by Şahin et al. (17) for quails fed supplementary vitamin C, vitamin E, and vitamin C + E combined rations respectively, and the 12.10 g reported by Okan (19). The differences could occur because of some factors such as the origin of the animals, vitamin C levels, stress levels, ration composition and management conditions. The highest and lowest egg weight means were 9.89 g and 9.63 g in treatment II and treatment III groups, respectively. The egg weight mean of the control group was similar to that of the treatment groups. The fact that the highest egg production was obtained in the lowest egg weight mean group could be explained by the negative correlation between egg production and egg weight (26). The egg weight mean was highest in treatment II, similar to the control group mean; treatment I and treatment III means were lower than treatment II and control group means without any statistical significance. Vitamin C supplementation appears to have no prominent effect on egg weight. Only the egg weight mean of treatment II was parallel with some studies about the positive effect of dietary vitamin C supplementation on egg weight (13,14).

In spite of the fact that treatment II had the highest feed consumption, 20.05 g/quail per day, there was no statistical significance between the groups ($P > 0.05$). This mean was lower than the 26.4 g mean reported by Nazlıgül et al. (27). Many researchers determined that increased environmental temperature causes a decrease in feed consumption (2-4). Another related study (20) reported 23.15 g feed consumption, which is similar to that found in the present study. Several studies speculated that dietary vitamin C supplementation has no effect on feed consumption or feed conversion ratio in extreme ambient temperatures (13,14,21).

In the present study, the highest and lowest feed conversion ratio means were 288.54 and 274.95 g/dozen eggs in treatments II and III, respectively. Quails fed with 500 ppm dietary vitamin C had a better feed conversion rate, in spite of no statistically insignificant difference between the groups. The feed conversion ratios found in our study were lower than the 354 g/dozen eggs declared by Önol et al. (20). The results of this trait are in agreement with the findings of some studies about the feed conversion ratio of quails reared under heat stress (15).

The eggshell weight means of the present study are similar to the result reported by Nazlıgül et al. (27), but lower than the results reported by Önol et al. (20) and Şahin et al. (17). The eggshell weight of treatments I and III were significantly lower than that of the control and treatment II groups ($P < 0.001$). The highest eggshell weight was in treatment II. Control and treatment II group means were higher than those of the other groups and this can be explained by the higher egg weight in these groups.

The mean eggshell thickness of the control and treatments I, II and III were 204.48, 204.20, 205.76 and 202.56 µ, respectively. These are in agreement with literature values. Vogt (28) reported that quail eggshell thickness differs from 0.2 to 0.3 mm. Statistical differences in eggshell thickness were not significant among the groups. The highest eggshell thickness mean was found in treatment II (205.76 µ). The eggshell thickness means found in the current study were similar to the 0.206 mm mean reported by Nazlıgül et al. (27), and lower than the results reported by Okan (19) for air cell, equator and sharp end of the egg means.

The results of the present study revealed that dietary vitamin C supplementation has a significant effect on egg production, egg weight and eggshell weight in Japanese quails reared under heat stress. On the other hand, its effects on livability, feed consumption and feed conversion ratio were not significant.

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