Effect of Combined Vitamin C and Vitamin E Supplementation on Reproductive Performance and Hatching Rate in Japanese Laying Quail

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Abstract: This study was carried out to evaluate the effect of vitE (Vitamin E) supplementation in combination with vitC (Vitamin C) on reproductive performance and hatching rate of Japanese quail at the age of 59-114 days. A total of 132 laying quails were arranged in a completely randomized design with 3 treatments and 4 replicates, each replicate being 9 female quails and 2 male quails at 59 days of age. The experimental treatments were as follows: control fed the basal diet (KPCS), E125C75 including KPCS supplemented with 125 mg vitE/kg feed combined with 75 mg vitC/kg feed and E125C125 including KPCS supplemented 125 mg vitE/kg feed combined with 125 mg vitC/kg feed. Research results showed that the highest WG (Weight Gain) was in E125C125 (30.32 g) and lowest in E125C75 (17.37 g). There were no statistically significant differences between treatments in terms of laying rate, feed conversion ratio, egg mass and egg weight. However, hatching rate and bodyweight of quails at 1 day of age were significantly different between treatments, the highest was E125C125 (74.37% and 7.43 g), followed by E125C75 (70.02% and 7.03 g) and the lowest was control (65.89% and 6.82 g). It can be concluded that E125C125 not only improved laying rate but also increased hatching rate and bodyweight of quail chick.

Key words: Laying rate, hatchability, BW (Body Weight), quail.

1. Introduction

Heat stress has a negative impact on broilers and laying hens, not only reducing growth rate and egg production, but also reducing the quality and safety of poultry and eggs [1, 2]. Therefore, in order to limit the negative effects of heat stress on laying hens, nutrition is one of the issues that should be taken care of instead of investing in a rather expensive cold house system [3]. For this purpose, vitE (Vitamin E) and vitC (Vitamin C) supplements have been widely used in diets because of their anti-stress ability and the synthesis of anti-stress active substances that increase the laying rate and egg quality in farm animals. VitE and vitC are antioxidants that play an important role in the animal body, vitE works individually or synergistically with vitC to perform antioxidant functions in lipid phases while vitC enhances the antioxidant properties of vitE by reacting with peroxyl radicals [2, 4]. Therefore, the combination of these two vitamins in improving performance in poultry is of interest to many scientists. Recent studies have shown that supplementing with 125 mg vitE/kg feed in combination with 250 mg vitC/kg feed improved performance and quality of Isa Brown hens at 41-51 weeks of age [5]. The combined supplementation of 75 mg vitC/kg feed with 75, 100 and 125 mg vitE/kg feed in laying quail 49-132 days old showed no significant difference in reproductive performance or egg quality [6]. Meanwhile, Nguyen et al. [7] showed E100C100 had the highest total egg production and egg weight, E125C125 improved feed consumption and feed conversion ratio, while E75C75 had higher in albumin and Haugh index when supplemented with...
vitC in combination with vitE in the diet in 71-105 days old Japanese quail. There were differences in the results of the combined use of these two vitamins in the above studies, so the purpose of this study was to evaluate the effects of vitE and vitC combined supplementation at different levels on reproductive performance and hatching rate of 56-112 days old Japanese quail.

2. Material and Methods

The experiment was carried out on 132 Japanese quails from 59 to 114 days old. All experimental quails were raised in the open cages, cages for quails with dimensions of 50cm × 40cm × 40cm. Each cage had 3 floors, each floor consisted of 3 cells, below each cage there is a plastic trough to collect manure. Drinking water was taken from the water company, with an automatic drinking trough arrangement to ensure sufficient water supply for the quails.

The basal diet used in the experiment was a pelleted compound feed with a protein content of 21.4% and a metabolic energy of 2,650 kcal/kg which was calculated to meet the nutrient requirement recommended by NRC (National Research Council) [8]. Vitamin E in the form of pure fine powder is milky white, odorless, tasteless; and vitamin C powder, milky white, scented was purchased from Mitaco Co., Ltd., Thanh Thuan hamlet, Dong Thanh commune, Chau Thanh district, Hau Giang province, Vietnam.

A total of 132 Japanese quails were arranged in a completely randomized design with 3 treatments and 4 replicates, each replicate being 11 experimental quails including 2 males and 9 female quails at 59 days of age. The treatments were as follows:

The control (Con) consisted of basal diet (KPCS) without supplementation;

E125C75 includes KPCS supplemented with 125 mg vitE/kg feed combined with 75 mg vitC/kg feed; and

E125C125 includes KPCS supplemented with 125 mg vitE/kg feed and 125 mg vitC/kg feed. VitE and vitC were mixed directly into the feed and fed every 3 days.

All quails in the experiment were reared under the same conditions. Quails were fed twice a day at 8 am and 3 pm with a daily feed consumption of 22 g/bird. The feeder and drinker were cleaned daily. The experimental quails were weighed at the beginning of term at 59 days of age and ended at 114 days of age. Quail eggs in each cage were collected and recorded in terms of quantity and weight daily at 9 am, in addition, abnormal eggs such as thin, broken shells were also recorded.

A total of 1,246 eggs were selected with a weight greater than 9.5 g, well-proportioned shape. All eggs were treated with an ultraviolet (UV) sterilizer (Box 856, DelMar) before being placed in the incubator (Ova Easy 580 Advance EX Series II, Brinsea, Japan). Egg weight, hatching time, hatchability and chick weight at 1 day of age were recorded.

All data were analyzed by analyzing variance procedures (ANOVA (Analysis of Variance)) and Tukey’s test was used to compare the mean between treatments when the $p$ value was less than 0.05.

3. Results and Discussion

The average temperature in the experimental house in the morning was 27.84 °C and in the afternoon was 30.36 °C, corresponding to the recorded humidity of 72.70% and 63.41%, respectively.

The results of Table 1 showed that the WG (Weight Gain) had a statistically significant difference between the treatments ($p<0.05$), the highest WG was at E125C125 (30.32 g) and the lowest was at E125C75 (17.37 g). The BW (Body Weight) of the experimental quails at the beginning and end of the experiment did not have statistical significant between treatments ($p>0.05$).

The laying rate of quail in E125C125 tended to be higher than other treatments at different age stages (Fig. 1), however, there was no statistically significant difference between treatments ($p>0.05$). For the average laying egg rate of quail at 59-114 days old, E125C125
was 59.57%, control was 57.89% and E125C75 was 56.42%. Similarly, there was no significant difference in quail egg weight between treatments over weeks of age ($p > 0.05$), although there was a greater improvement in egg weight in E125C125 and E125C75 compared with control (Table 2).

FCR (Feed Conversion Ratio) and egg mass between treatments were not statistically significant ($p > 0.05$). Feed conversion ratio was in range of 4.23-5.29 kg feed/kg egg and egg mass was 5.79-6.05 g egg/hen.

### Table 1  BW and total WG of the experimental quails.

| Parameters             | Treatments | SEM  | $p$ |
|------------------------|------------|------|-----|
|                        | Con        | E$_{125}$C$_{75}$ | E$_{125}$C$_{125}$ |      |
| Initial BW, g/bird     | 162.8      | 159.97 | 157.53 | 2.97 | 0.176 |
| Final BW, g/bird       | 183.06     | 177.34 | 187.85 | 3.62 | 0.125 |
| Total WG, g/bird       | 18.91$^b$ | 17.37$^b$ | 30.32$^a$ | 3.16 | 0.008 |

$^a$, $^b$ values with different superscripts in the same row differ significantly, $p < 0.05$. SEM: Standard Error of the Mean.

### Table 2  Egg weight, FCR and egg mass of the experimental quail.

| Parameters             | Treatments | SEM  | $p$ |
|------------------------|------------|------|-----|
|                        | Con        | E$_{125}$C$_{75}$ | E$_{125}$C$_{125}$ |      |
| EW (Egg Weight), g/egg | $d_{59-65}$ | 9.31 | 9.42 | 9.23 | 0.12 | 0.575 |
|                        | $d_{66-72}$ | 9.48 | 9.40 | 9.53 | 0.04 | 0.135 |
|                        | $d_{73-79}$ | 9.93 | 9.78 | 10.14 | 0.23 | 0.569 |
|                        | $d_{80-86}$ | 10.24 | 10.39 | 10.57 | 0.19 | 0.499 |
|                        | $d_{87-93}$ | 10.36 | 10.88 | 10.94 | 0.19 | 0.104 |
|                        | $d_{94-100}$ | 10.64 | 11.06 | 10.99 | 0.19 | 0.494 |
|                        | $d_{101-107}$ | 10.54 | 10.98 | 11.07 | 0.25 | 0.330 |
|                        | $d_{108-114}$ | 10.66 | 10.68 | 10.81 | 0.09 | 0.293 |
|                        | $d_{59-114}$ | 10.14 | 10.33 | 10.41 | 0.115 | 0.293 |
| FCR, g feed/g egg      | $d_{59-65}$ | 9.34 | 11.90 | 17.86 | 2.81 | 0.145 |
|                        | $d_{66-72}$ | 4.54 | 5.57 | 5.55 | 0.58 | 0.339 |
|                        | $d_{73-79}$ | 3.27 | 4.32 | 4.19 | 0.49 | 0.306 |
|                        | $d_{80-86}$ | 3.52 | 3.69 | 3.18 | 0.23 | 0.352 |
|                        | $d_{87-93}$ | 3.48 | 3.30 | 2.94 | 0.18 | 0.150 |
|                        | $d_{94-100}$ | 2.92 | 2.91 | 2.77 | 0.21 | 0.840 |
|                        | $d_{101-107}$ | 3.42 | 2.97 | 2.95 | 0.15 | 0.095 |
|                        | $d_{108-114}$ | 3.31 | 3.06 | 2.85 | 0.18 | 0.340 |
|                        | $d_{59-114}$ | 4.23 | 4.71 | 5.29 | 0.48 | 0.309 |
| Egg mass, g egg/hen    | $d_{59-65}$ | 2.52 | 1.91 | 1.61 | 0.40 | 0.319 |
|                        | $d_{66-72}$ | 4.85 | 4.07 | 4.09 | 0.48 | 0.407 |
|                        | $d_{73-79}$ | 6.73 | 5.50 | 5.29 | 0.64 | 0.283 |
|                        | $d_{80-86}$ | 6.18 | 6.05 | 6.90 | 0.41 | 0.341 |
|                        | $d_{87-93}$ | 6.28 | 6.71 | 7.42 | 0.37 | 0.139 |
|                        | $d_{94-100}$ | 7.46 | 7.61 | 8.06 | 0.55 | 0.732 |
|                        | $d_{101-107}$ | 6.40 | 7.17 | 7.42 | 0.28 | 0.077 |
|                        | $d_{108-114}$ | 6.55 | 7.33 | 7.64 | 0.48 | 0.309 |
|                        | $d_{59-114}$ | 5.87 | 5.79 | 6.05 | 0.34 | 0.857 |
The laying rate of quail (%).

Fig. 1

Table 3 The hatching rate and BW of quail chicks.

| Parameters                   | Treatments          | SEM | p    |
|------------------------------|---------------------|-----|------|
| Egg weight, g/egg            | Con     | E125C75 | E125C125 |
| Hatchability, %              | 65.89\(^b\) | 70.72\(^ab\) | 74.37\(^a\) |
| 17th day of hatch, %         | 56.77    | 56.97   | 57.02   |
| 18th day of hatch, %         | 43.23    | 43.04   | 42.99   |
| BW of chick, g/bird          | 6.82\(^b\) | 7.03\(^ab\) | 7.43\(^a\) |

\(^a, b\) values with different superscripts in the same row differ significantly, \(p < 0.05\).

The results on hatching rate and BW of quail chicks were presented in Table 3. The hatching rate and BW of quail chicks were significantly different between treatments, the highest was at E125C125 (74.37\% and 7.43 g/bird), followed by E125C75 (70.72\% and 7.03 g/bird) and the lowest was in control (65.89\% and 6.82 g/bird). The hatching rate on day 17 (56.77\%-57.02\%) was higher than on day 18 (42.99\%-43.23\%), but there was no difference between treatments.

The regression equation was \(EW = 5.19 + 0.742 BWc\). The results of the regression analysis showed that there was a correlation between \(EW\) and \(BWc\) (Body Weight of Chick).

The ideal temperature for laying hens is 20 °C [9] because high temperatures cause heat stress, and corticosterone increases the conversion of norepinephrine to epinephrine, causing follicular degeneration [10]. In this study, the laying quails were reared in open cage conditions, with high temperature of 27.84-30.36 °C, this can reduce egg production due to reduced feed intake or nutrient content, supplemented with vitE and vitC into the diet which significantly improved the fertility of birds compared with the control. Indeed, under heat stress, poultry cannot synthesize vitC sufficiently [11], so vitC supplementation is necessary to regulate body temperature [12]. VitC has been shown to enhance the antioxidant activity of vitE by reducing tocopheroxyl radicals back to the active form of vitE [13]. Dietary vitE supplementation facilitates the release of vitellogenine essential for oocyte formation because heat stress reduces vitellogenine synthesis and release [4]. In addition, vitE prevents oxidation of dietary unsaturated fats that contribute to egg formation [14]. Other results have also shown that diets supplemented
with vitE and/or vitC for heat-stressed birds can improve not only reproductive performance, feed conversion, but also egg quality [5, 15-19]. The results of the present experiment on laying rate also showed that the combined diets of vitE and vitC at 125 mg/kg feed tended to improve the laying rate by 3.17-9.13 eggs compared with the control. The results of this experiment were similar to the report by Khang et al. [6] that the combination of vitE and vitC supplementation improved reproductive performance of quail at 49-132 days old although not statistically significant. As a result, laying quails fed a supplemented diet with a combination of vitE and vitC showed a better effect on hatchability (4.83%-8.48%) and BW of chick (0.21-0.61 g). This result may be due to the positive effect of dietary vitE on the antioxidant status of sperm storage sites in hens [20]. Hooda et al. [21] results showed that mating males with females after both were fed a diet supplemented with vitE that resulted in better fertility and hatchability of quail eggs. Additionally, Yoshida and Hoshii [22] recommended an intake of more than 500 μg of vitE per egg to ensure healthy hatching chicks. Another study reported that vitE levels in eggs should be increased through supplementation in the mother’s diet if chicks hatched with vitE deficiency [23].

5. Conclusions

Supplementing with vitC and vitE at a dose of 125 mg/kg of feed for each vitamin improved the WG of laying quail, hatching rate and BW of quail chicks.

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