The consistency of quail’s egg production supplemented with vitamin C in the diets

A Ratriyanto, T Nugroho, A Masykur, B F Hidayat, S Prastowo, Sunarto and N Widyas
Department of Animal Science, Sebelas Maret University, Surakarta, Indonesia
E-mail: ratriyanto@staff.uns.ac.id

Abstract. In tropical area, animals are prone to stress due to high environmental temperature hence affecting the production. Vitamin C has been offered as an agent to help animal to cope with heat stress. This paper aimed to estimate the consistency of quail’s egg production supplemented with vitamin C through repeatability estimates. A total of 136 quails (Coturnix coturnix japonica) were randomly allotted into 2 dietary treatments with 4 replicates each containing 17 quails. The dietary treatments were basal diet (T0) and basal diet + 250 mg/kg vitamin C (T1). Dietary treatments were given for 8 weeks in laying phase. In total we obtained 56 days of egg production data. Data were analysed using t-test to infer the differences between the treatments and analysis of variance (ANOVA) to obtain the repeatability value. The results showed that the supplementation of vitamin C increased egg production up to 14.3% (P<0.01). Repeatability value of T0 was higher (0.33) than T1 (-0.13). Quails given T0 has a high egg production consistency but produce lower egg production than T1. It is concluded that supplementation of vitamin C increased egg production but were not yet able to produce the optimal consistency.

1. Introduction
Egg production as an important trait in poultry industry is affected by both genetic and environmental factors [1,2]. Genetic effect contained information regarding the potential of the animals in producing eggs while the environment served as the supporting factor. Hence, no matter how superior an individual genotype is, it will never reach its optimum condition without the support of the environment. Environmental factor can be theoretically divided into two parts: the permanent environment and the temporary environment which roles in an individual’s phenotype differed [1,3]. The environment which an individual experienced during early life such as non-direct maternal effects will leave a permanent influence on its phenotype. Meanwhile, other types of environment such as weather and diets will only affect an individual’s phenotype temporarily. The change in the later effect will be followed by the change in phenotype as a response.

High ambient temperature in the tropics becomes a significant challenge in poultry production and impairs feed intake, physiology and performance of poultry, including laying quails [4]. Poultry are susceptible to heat stress, particularly when kept above the thermoneutral zone of 18–22°C [5,6]. Various techniques can be practiced to alleviate heat stress in poultry, including many nutritional strategies [4,7]. One of the nutritional strategies to alleviate stress in laying quails is the use of Vitamin C in the diet [8].
Vitamin C is one of the important antioxidants and plays a role in immune formation [9]. Vitamin C can be synthesized in the body of poultry, however, high ambient temperature can cause a decrease in nutrient absorption and a decrease in the concentration of nutrients in the blood, including vitamin C [8]. In stressful conditions (for example due to density, high temperature, humidity), the synthesis of vitamin C in the body decreases or the vitamin C requirement increases, leads to insufficiency of vitamin C. Therefore, it is necessary to provide vitamin C in the diet or drinking water [9] as an anti-stress to maintain or improve the performance of poultry [5].

By adding the vitamin C, we wished to manipulate the temporary environmental effect. It is interesting to see how the quail will response this supplementation from the production point of view. The aim of this article is to present the difference in egg production consistency of quails fed with and without vitamin C supplementation in tropical climate and to observe how much egg production trait is affected by the temporary environmental effect which is vitamin C supplementation.

2. Materials and Methods

2.1. The feeding experiments

A population of 136 quails were used in the experiment. The quails were divided into two distinct treatments: basal diet as control (T0; Table 1) and basal diet + 250mg vitamin C supplementation (T1). Each diet treatment was replicated four times with 17 individual quails per flock (as the replicate).

| Nutrient                   | Content |
|----------------------------|---------|
| Metabolizable energy (kcal/kg) | 2,800.00 |
| Crude protein (%)          | 18.00   |
| Lysine (%)                 | 1.04    |
| Methionine (%)             | 0.45    |
| Calcium (%)                | 3.40    |
| Phosphorus (%)             | 0.50    |

Quails were obtained from a village breeding center at the age of 23 weeks and were immediately given the basal diet. The quails were slowly adapted into the experimental diet; this adaptation period lasted for 4 weeks. The experimental diets were given from age 28 and the egg production data was recorded for 8 weeks.

2.2. Data analyses

Egg production data was recorded daily as the percentage of eggs produced by each flock relative to the number of birds in the flock at each day. However, the data used in the analysis was weekly averaged egg production. Data analyses were performed using custom scripts of R programming language [10].

Given that we intended to compare the difference of eggs production between two diets, two-samples independent t-test was performed under 5% significance level. The hypothesis was then formulated as $H_0: \mu_1 = \mu_2$, where $\mu_1$ was the mean of control group and $\mu_2$ was the mean of group with vitamin C supplementation. We assumed that the datasets were ~iid, $N(\mu, \sigma^2)$; no collinearity as well as autocorrelations were found among analysed variables. A common two sample t-test formula was utilized to test the hypothesis as in the following model:

$$y_{ij} = \mu + \tau_i + \epsilon_{ij}$$
We denoted that \( y \) was the observed variables, which was the egg production, \( \mu \) was the general mean, \( \tau_i \) was the effect of the \( i \)-th treatment and \( e_{ij} \) was the random residual term of diet \( i \) and replicate \( j \) where \( e \sim N(0, \sigma^2_e) \).

The consistency of eight consecutive weeks egg production between treatments were observed by employing intraclass correlation procedure for both diets. Datasets were partitioned into weekly egg production. Intra class correlation procedure was conducted for each diet following a linear model with week as the systematic factor.

\[
y_{ij} = \mu + w_i + e_{ij}
\]

Where \( y \) was the egg production of a diet, \( \mu \) was the general mean, \( w_i \) was the effect of \( i \)-th week and \( e \) was random residual. Intraclass correlation was estimated as:

\[
\hat{\rho} = \frac{\sigma^2_w}{\sigma^2_w + \sigma^2_e}
\]

With \( \hat{\rho} \) was the estimated intraclass correlation; \( \sigma^2_w \) is the between week variance which the difference between Mean squares (MS) between week and MS residual. Whereas \( \sigma^2_e \) was residual variance which nominal was \((k-1)\text{MS residual}; k = 8 \) which was the number of weeks.

### 3. Results and Discussion

#### 3.1 Explorative data analysis

The comparison of egg production (averaged for eight week) between diets is presented in Table 2. The vitamin C supplementation has significant effect \( (P < 0.05) \) on quails’ egg production. This signify our hypotheses that vitamin C helped the quails to cope with the environmental pressure and thus the egg production is higher.

| Treatments | Minimum | Maximum | Mean±sd | P-value |
|------------|---------|---------|---------|---------|
| Control    | 41.18   | 100     | 73.82±12.48 | P<0.01 |
| Vit C      | 52.94   | 100     | 84.38±9.79  |         |

We later analyse the data each week and plot the egg production trends for both diets as in Figure 1. It can be seen that quails supplemented with vitamin C produce remarkable more eggs compared to the control and this trend is consistent throughout the experimental period.
3.2. Intraclass correlation

We run single score intraclass correlation to check the consistencies of egg production for each treatment. The analysis was done under the null hypothesis that there were no correlations among egg productions over different weeks. The results were presented in Table 3.

| Parameters                  | Treatment |     |
|-----------------------------|-----------|-----|
| Number of repeated measure  | Control   | 8   |
|                             | Vit C     | 8   |
| Intraclass correlation      | Control   | 0.33|
|                             | Vit C     | -0.13|
| P-value for hypotheses      | Control   | 0.02|
|                             | Vit C     | 0.81|

The records were available for eight consecutive weeks during the experiment each with four replicates. We subjected the intraclass correlation to observe the consistency of egg production across this time period. From the p-value we can deduce that the on the control treatment, there is correlation among the eight week of egg production with a value of 0.33. This value represented the repeatability estimate of egg production of the control quails. Biologically speaking, 33% of the variation in egg production of the control population were affected by genetic and permanent environmental effect [2,11] while the rest were affected by temporary environment during the data collections. On the other hand, there is almost no noticeable correlation among observations in egg production of quails with vitamin C supplementation (P>0.05) with intraclass correlation value of -0.13. The low value of intraclass correlation of the quails supplemented with vitamin C suggested that the egg production in this population over eight weeks were more affected by the specific condition of each observation time point instead of the permanent effects. Heat exposure increased serum corticosterone levels and Hsp70 expression. Serum corticosterone level was significantly decreased by vitamin C or E supplementation in the groups for quail [12]. In the previous study, vitamin C or E supplementation significantly improve feed intake, improve growth, and egg production by buffering heat stress effect [7,8,13]. This finding justified that vitamin C supplementation played the role of temporary environment for the quails during their production.
4. Conclusion

It is concluded that supplementation of vitamin C increased egg production but was not able to produce the optimal consistency.

References

[1] Falconer D S and Mackay T F C 1996 *Introduction to Quantitative Genetics* (Edinburgh: Prentice Hall)
[2] Hardjosubroto W 1994 *Aplikasi Pemuliaan Ternak di Lapangan* (Jakarta: Gramedia Wijayaarana Indonesia)
[3] Lynch M and Walsh B 1998 *Genetics and Analysis of Quantitative Traits* (Sunderland, MA: Sinauer Associates, Inc)
[4] Chand N, Muhammad S, Khan R U, Alhidary I A and Rehman Z U 2016 Ameliorative effect of synthetic γ-aminobutyric acid (GABA) on performance traits, antioxidant status and immune response in broiler exposed to cyclic heat stress *Environ. Sci. Pollut. Res.* 23 23930–5
[5] Khan R U, Naz S, Nikousefat Z, Selvaggi M, Laudadio V and Tufarelli V 2012 Effect of ascorbic acid in heat-stressed poultry *Worlds. Poult. Sci. J.* 68 477–89
[6] Khan R U, Naz S and Dharma K 2014 Chromium: Pharmacological applications in heat-stressed poultry *Int. J. Pharmacol.* 10 213–7
[7] Farooqi H A G, Khan M S, Khan M A, Rabbani M, Pervez K and Khan J A 2005 Evaluation of betaine and vitamin C in alleviation of heat stress in broilers *Int. J. Agric. Biol.* 7 744–6
[8] Sahin K, Sahin N, Onderci M, Gursu M F and Issi M 2003 Vitamin C and E can alleviate negative effects of heat stress in Japanese quails *Food, Agric. Environ.* 1 244–9
[9] Sahin K, Onderci M, Sahin N, Gursu M F and Kucuk O 2003 Dietary Vitamin C and Folic Acid Supplementation Ameliorates the Detrimental Effects of Heat Stress in Japanese Quail *K. J. Nutr.* 133 1882–6
[10] R Core Team 2015 R: A language and environment for statistical computing
[11] Bourdon R M 2000 *Understanding Animal Breeding* (Prentice Hall)
[12] Sahin N, Tuzcu M, Orhan C, Onderci M, Eroksuz Y and Sahin K 2009 The effects of vitamin C and E supplementation on heat shock protein 70 response of ovary and brain in heat-stressed quail *Br. Poul. Sci.* 50 259–65
[13] Abdulrashid M, Agwunobi L and Hassan M 2004 *Ascorbic acid and heat stress in domestic chicken nutrition: A review* vol 8 (Department of Animal Science, University of Benin)