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Analysis of the Trend of Age-Related Laying Performance of Quail (*Coturnix coturnix*)

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ABSTRACT

For China yellow quail, Beijing white quail and Korean quail, number of eggs, total egg weight and laying rate begin to soar up with the increase of age from the 8th week to 12th week. Such growth rate declines gradually with the increase of age from the 12th week to the 15th week. The best regression equation for the number of eggs of Beijing white quail, Korean quail and Chinese yellow quail to week-age were: $Y=-12.153+1.850X-0.003X^3$ ($R^2=0.991$), $Y=-14.367+3.110X-0.121X^2$ ($R^2=0.881$) and $Y=-12.096+2.954X-0.116X^2$ ($R^2=0.833$), respectively. The best regression equations of the total egg weight of Beijing white quail, Korean quail and Chinese yellow quail to week-age were: $Y=-142.558+21.406X-0.037X^3$ ($R^2=0.991$), $Y=-180.768+38.405X-1.508X^2$ ($R^2=0.888$) and $Y=-150.305+34.794X-1.362X^2$ ($R^2=0.882$), respectively. The best regression equations of laying rate of Beijing white quail, Korean quail and Chinese yellow quail to week-age were : $Y=-162.468+25.068X-0.043X^3$ ($R^2=0.988$), $Y=-170.629+38.775X-1.503X^2$ ($R^2=0.901$) and $Y=-115.539+32.834X-1.283X^2$ ($R^2=0.835$), respectively. The best regression equation of feed egg ratio of Beijing white quail was $Y=34.482-4.695X+0.175X^2$ ($R^2=0.929$).

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Authors' Contribution
JYB conceived and designed the study and conducted the lab work. ZHD and YC analyzed the data and wrote the article. JYL, YL and YBY helped in sampling. KPS and XYF helped in analysis of data

Key words
***Coturnix coturnix*, Number of eggs, Total egg weight, Regression analysis, Week-age.**

INTRODUCTION

Quail cultivation is characteristic of small investment, small scale, short growth period and short earning cycle. Hence, it is highly appreciated by farmers and enjoys a promising market development prospect. According to comparative analysis of Beijing Food Research Institute on nutrients between 100g quail meat and 100g chicken, quail meat contains 22.2% proteins, which is higher than that in chicken (21.5%). In particular, quail eggs contain abundant essential amino acids which are easy to be absorbed by human body (*e.g.* phenylalanine, tyrosine, leucine) in proteins as well as mineral elements, multivitamins, lecithins, cephalins and hormones. Therefore, quail eggs are the ideal goods for body nourishing and improvement. Currently, quail cultivation is more and more popular in poultry. Besides, quail which has smaller size than other poultries can be used as a good new type of test animal. Quail also can be used as experimental animals in multiple subjects, such as poultry propagation, histology, nutriology, hemadenology, embryology, physiology and pharmacology. In recent years, a lot of studies have been carried out on quail production performance (Bai *et al*., 2020), genetic diversity (Bai *et al*., 2013, 2016), gene function (Li *et al*., 2019). In order to improve the laying performance of quail in production, this study analyzed the trend of laying performance with week-age.

MATERIALS AND METHODS

Experimental materials

Female samples (n=50) of China yellow quail, Beijing white quail and Korean quail were collected, respectively. All samples were cultured in single cage which had been sterilized strictly before the experiment. Spraying sterilization was performed regularly to all cages during the experiment. All cages were piled up completely into four layers. The culture room was provided with 24 h light and quails were allowed to drink water and eat freely throughout the experiment. Fodders were supplemented artificially on the morning and evening every day. The culture temperature and humidity were determined according to culture management requirements. The experimental period started from the first week and ended at the 17th week.

Number of eggs, total number of eggs per quail from production to the 17th week; total egg weight, total egg weight per quail from production to the 17th week; laying rate, egg laying percentage of quail in the statistical period; feed egg ratio, it is the ratio between feed amount and total egg weight of quail.

Data analysis

Using Excel software to draw the trend chart of

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quail's egg laying performance to week-age, using SPSS software to build the regression equation of quail's egg laying performance to week-age, and draw the regression trend chart.

RESULTS

Variation laws of egg laying performance with age

It can be seen from Figure 1 that from 8~15 weeks, number of eggs, total egg weight and laying rate of China yellow quail are higher than those of Beijing white quail and Korean quail, but the feed-gain ratio is lower. This reflects that China yellow quail has the best egg laying performance, and Beijing white quail shows the poorest egg laying performance. From 8~12 weeks, number of eggs, total egg weight and laying rate of all three egg quail species increase quickly with the increase of week-age. Such growth rate decreases from 12-15 weeks. Feed egg ratio of all three egg quail species decreases quickly from the 8th week to the 12th week, but such reduction rate also declines or remains basically stable from the 12th week to the 15th week.

Regression analysis of laying performance of quail to age

Regression equations of number of eggs, total egg weight, laying rate and feed egg ratio of three egg quails about week-age are shown in Figure 2. Clearly, the quadratic and cubic regression equations show the best fitting effect, while logistic and logarithmic regression equations have the poorest fitting effect. This is because the real observation data scattering points of these indexes are significantly different from regression curves of logistic and logarithmic regression equations.

It can be seen from Supplementary Table I. that the cubic regression equation of number of eggs about week-age of the Beijing white quail is the best, with a degree of fitting of 0.991. The best regression equation is $Y=-12.153+1.850X-0.003X^3$. The degrees of fitting of the quadratic regression equation and logarithmic regression equation are 0.989 and 0.906, indicating the good fitting effects of these two regression equations. However, fitting effects of S regression equation and logistic regression equation are relatively poorer. For Korean quail and China yellow quail, the cubic regression equation and quadratic regression equation of number of eggs about week-age

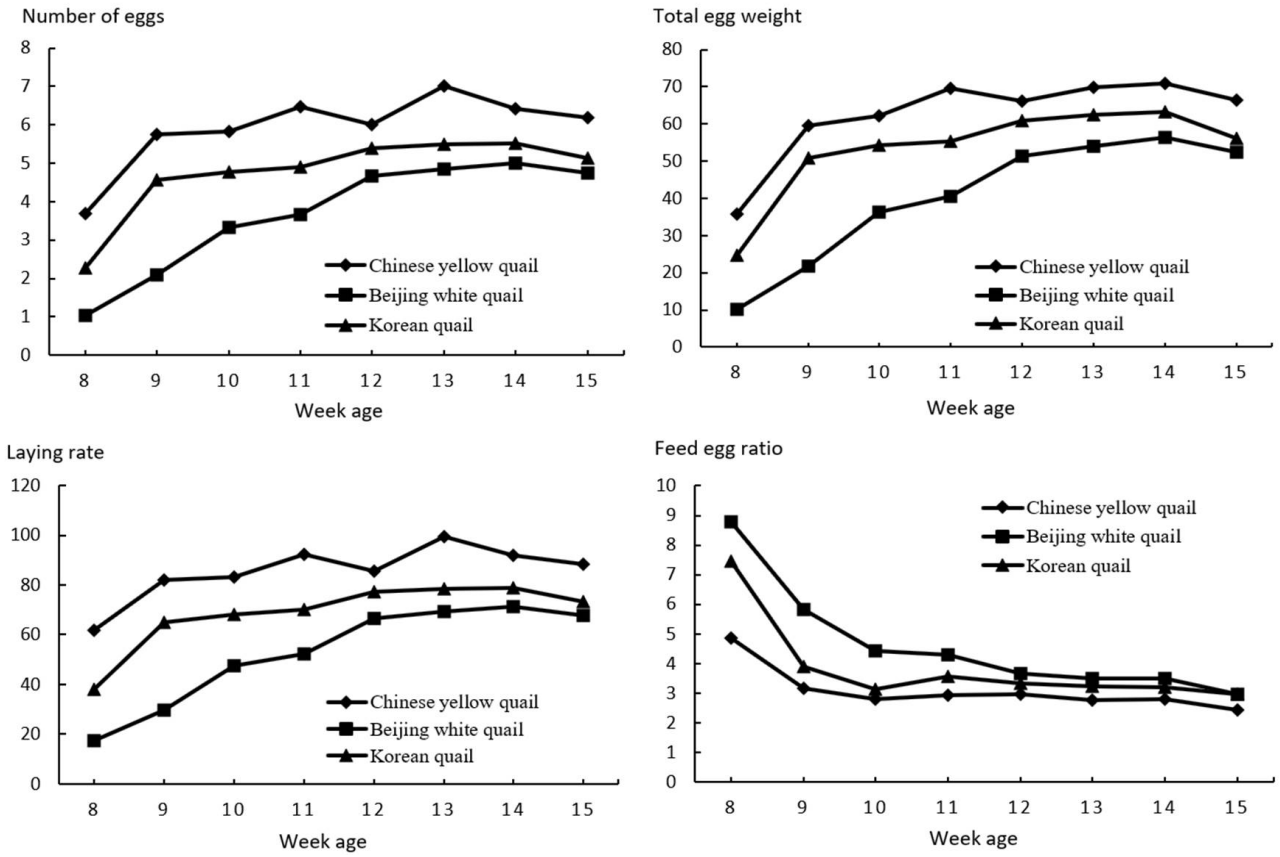

Fig. 1. Variation of egg laying performance (number of eggs, total egg weight, laying rate and fee-egg ratio) with age (week).

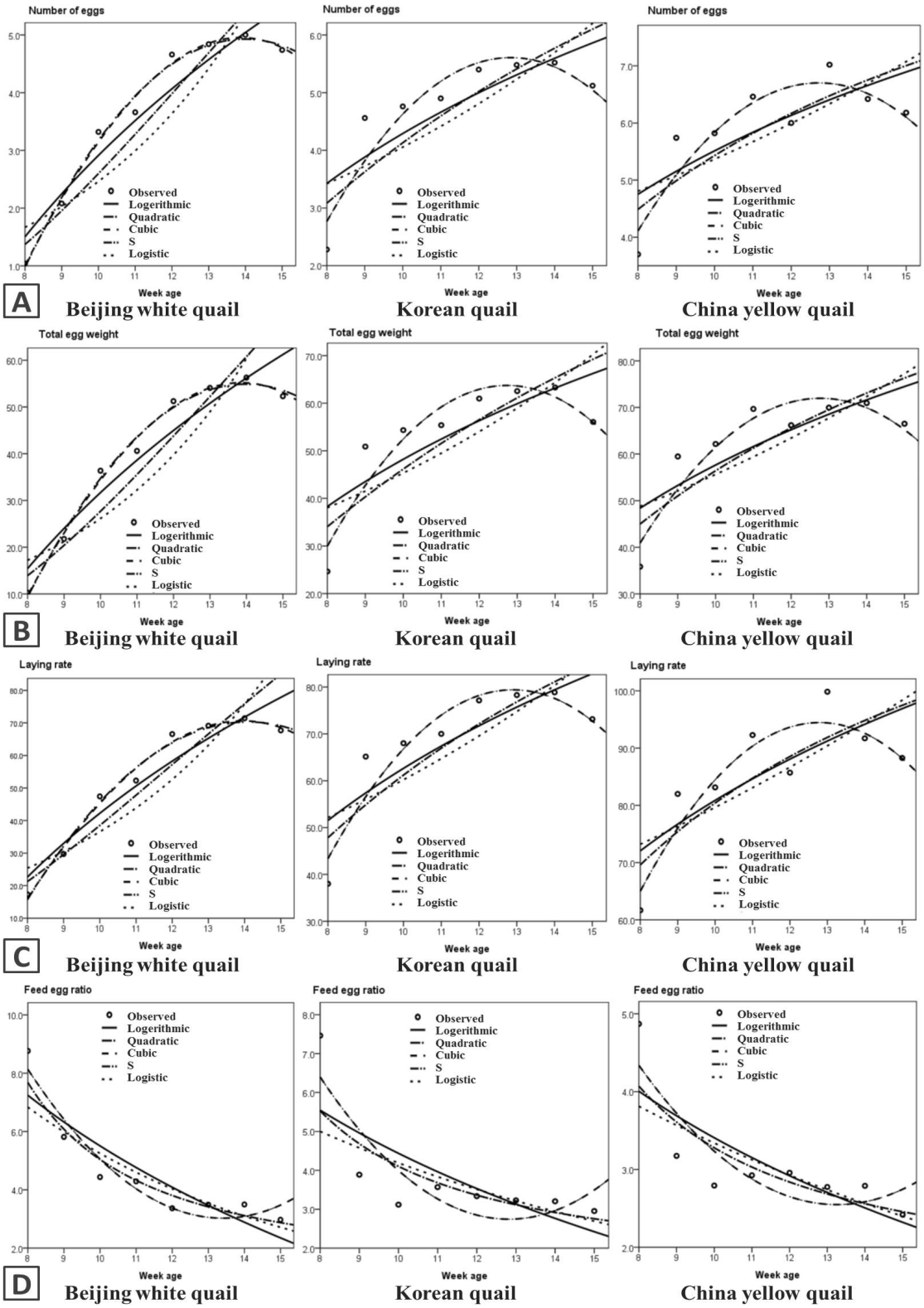

Fig. 2. Regression analysis of number eggs (A), total egg weight (B), laying rate (C) and fee-egg ratio (D) with reference to age (in weeks).

are the best. Their degrees of fitting are 0.881 and 0.881 as well as 0.833 and 0.833, respectively. Since the estimated values of b_0, b_1 and b_2 of the cubic regression equation are consistent with those of the quadratic regression equation and the estimated value of b_3 is 0, the best regression equations of number of eggs about week-age for Korean quail and China yellow quail are: $Y=-14.367+3.110X-0.121X^2$ and $Y=-12.096+2.954X-0.116X^2$. Degrees of fitting of logarithmic regression equation, S regression equation and logistic regression equation of Korean quail and China yellow quail are 0.643, 0.656 and 0.506 as well as 0.574, 0.631 and 0.482, respectively. Therefore, logarithmic regression equation, S regression equation and logistic regression equation show poor fitting effects.

For Beijing white quail, the cubic regression equation of total egg weight about week-age is the best, manifested by the degree of fitting of 0.991. The best regression equation is $Y=-142.558+21.406X-0.037X^3$. Degrees of fitting of quadratic regression equation and logarithmic regression equation are 0.990 and 0.905, indicating good fitting effect. On contrary, fitting effects of S regression equation and logistic regression equation are poorer. The cubic regression equation and quadratic regression equation of total egg weight about week-age for Korean quail and China yellow quail are the best, which are $Y=-180.768+38.405X-1.508X^2$ and $Y=-150.305+34.794X-1.362X^2$. Degrees of fitting of logarithmic regression equation, S regression equation and logistic regression equation for Korean quail are 0.614, 0.637 and 0.484. Degrees of fitting of logarithmic regression equation, S regression equation and logistic regression equation for China yellow quail are 0.625, 0.631 and 0.507. Therefore, logarithmic regression equation, S regression equation and logistic regression equation show the poorest fitting effect for Korean quail and China yellow quail.

The cubic regression equation of laying rate of Beijing white quail about week-age is the best: $Y=-162.468+25.068X-0.043X^3$. In addition, fitting effects of quadratic regression equation, logarithmic regression equation and S regression equation are better, manifested by 0.987, 0.910 and 0.903. Degree of fitting of logistic regression equation is 0.744. To sum up, S regression equation shows the poorest fitting effect. For Korean quail and China yellow quail, the cubic regression equation and quadratic regression equation of laying rate about week age are the best: $Y=-170.629+38.775X-1.503X^2$ and $Y=-115.539+32.834X-1.283X^2$. Degrees of fitting of logarithmic regression equation, S regression equation and logistic regression equation are 0.671, 0.692 and 0.542 for Korean quail. Degrees of fitting of logarithmic regression equation, S regression equation and logistic regression equation are 0.593, 0.662 and 0.517 for China yellow quail. In a word, logarithmic regression equation, S regression equation and logistic regression equation have the poorest fitting effect.

For Beijing white quail, the quadratic regression equation of feed egg ratio about week-age is the best (degree of fitting = 0.929): $Y=34.482-4.695X+0.175X^2$. Moreover, degrees of fitting of cubic regression equation and S regression equation are higher than 0.9, indicating the relatively good fitting effect. However, logarithmic regression equation and logistic regression equation show relatively poorer fitting effects (0.796 and 0.828). For Korean quail and China yellow quail, all five regression equations of feed egg ratio about week-age are not ideal, because degree of fitting is lower than 0.8.

DISCUSSION

Peng (2013) reported the egg laying peak of maroon egg quail is within 2-3 laying months and laying rate declines to a small extent in high-temperature seasons. In this study, laying rate of 3 egg quail species begins to be stable after 12 weeks. However, laying rate decreases after 15 weeks due to the hot weather conditions. The average laying rates at 12, 13, 14 and 15 weeks are 76.5%, 82.6%, 80.7% and 76.4%, respectively. This reflects that the laying rate remains basically stable from 12-15 weeks. Egg laying performance of all egg quail species is positively related with week age. This is similar with research results of Peng (2013). Moreover, the present study found that feed egg ratio of all three egg quail species is negatively correlated with week age of egg laying and the minimum is at the 15th week. Zita *et al*. (2012) showed that the egg weight of Japanese quail increased with the increase of week of laying (1-20 week of laying). The results of this study are similar to those of Zita *et al*. (2012). This study shows that the total egg weight of Chinese yellow quails, Beijing white quails and Korean quails increases with the 8-15 weeks-age (1-8 week of laying). In the 8-15 weeks-age, the number of eggs and laying rate of Chinese yellow quails are much higher than that of Korean quails and Beijing white quails, while the number of eggs and laying rate of Korean quails are much higher than that of Beijing white quails.

It can also be seen from this study that the number of eggs, total egg weight and laying rate of Chinese yellow quails are much higher than those of Korean quails and Beijing white quails in the 8-15 week-age, while the feed egg ratio of Chinese yellow quails is lower than that of the other two quails. Therefore, the laying performance of Chinese yellow quails is better than that of the other two quails. On the contrary, Beijing white quails have the lowest number of eggs, total egg weight and laying rate

in 8-15 week-age, but the highest feed to egg ratio, so the egg production performance of Beijing white quails is the worst. The laying performance of Korean quail is between Chinese yellow quail and Beijing white quail.

The fitting degree of the best regression equations of number of eggs, total egg weight and laying rate of Chinese yellow quail, Beijing white quail and Korean quail with week-age is more than 0.8. Therefore, these regression equations can be used to estimate and predict the number of eggs, total egg weight and laying rate of quail in different week-age.

CONCLUSION

For China yellow quail, Beijing white quail and Korean quail, number of eggs, total egg weight and laying rate begin to soar up with the increase of age from the 8th week to 12th week. Such growth rate declines gradually with the increase of age from the 12th week to the 15th week. The best regression equation of number of eggs, total egg weight and laying rate to week-age can be used to estimate number of eggs, total egg weight and laying rate.

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Supplementary material

There is supplementary material associated with this article. Access the material online at: https://dx.doi.org/10.17582/journal.pjz/20200621090652

Statement of conflict of interest

The authors have declared no conflict of interest.

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