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Predicting Yolk Height, Yolk Width, Albumen Length, Eggshell Weight, Egg Shape Index, Eggshell Thickness, Egg Surface Area of Japanese Quails Using Various Eggs Traits as Regressors

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Abstract: The research was conducted an eggs of Japanese quails maintained in cages at the research unit, Agricultural Faculty, University of Akdeniz, Turkey. Two hundred and forty eggs selected randomly. Egg weights (g), egg length (mm), egg width (mm), eggshell weight (g) and eggshell thickness (mm) were measured. The egg weight was better predictable from egg width and egg length. Following equation was developed to predict egg weight from egg width and length. Y = -21.658+0.828 *(X_1)+0.373 * (X_2). Where, Y= was predicted egg weight, X_1 = egg width, X_2 = egg length. Following equation was developed for predicting eggshell weight from egg weight, width and length. Y = 0.573+0.01532*(X_3)+0.0238* (X_4). Where, Y = was predicted eggshell weight, X_3 = egg length and X_4 = egg width. Egg shape index was predictable with sufficient accuracy from egg length and width and following equation was developed to predict it; Y = 0.79+0.0307*(X_5)-0.02423*(X_6). Where, Y = was predicted egg shape index, X_5 = egg width, X_6 = egg length. Eggshell surface area was better predictable from egg weight, width and length. So, following equation was developed for predicting eggshell surface area. Y = 10.561-0.178*(X_7) -0.045*(X_8)+1.535*(X_9). Where, Y = was predictable eggshell surface area, X_7 = egg width, X_8 = egg length, X_9 = egg weight.

Key words: Japanese quail, egg weight, egg length, egg width, shell weight and eggshell surface area

Introduction

The significance of animal proteins in sufficient and balanced nourishment is considerable for the human health with respect to the physical and mental progress (Uluocak *et al.,* 1995). Among such animal proteins sources, the poultry animals have a significant place due to numerous advantages contained. In the last years, it has been observed in the poultry breeding that the quails were benefited as much as hens both for their meat and eggs, therefore, commercial quail breeding have became widespread (Altinel *et al.,* 1996). Approximately 7-8% of the total amount of the eggs is broken throughout the transfer of the eggs from the breeders the consumers. So, especially the amount of cracked and broken eggs results in a serious economical problem both for the breeders and the dealers (Hamilton, 1982). Moreover, some of the egg quality traits have significant and direct effects on the prices of especially commercial flocks. In the egg processing enterprises, the weight of eggshell, albumen and the yolk that form the egg as well as their rates affect the amount and price of the product (Altan *et al.,* 1998). During the investigations made on the quality traits of the egg, the researchers had focused on the studies related to the increasing of the stiffness of the eggshell, because the quality of the eggshell has a vital importance for the laying force, embryo growth and the chick quality.

Egg weight was easily predictable from egg length and width as positive association among these traits existed (Farooq *et al.,* 2001). Information on egg weight along with egg width and length will further open the domain for trying out various prediction equations in order to predict eggshell weight and shell thickness (Khurshid *et al.,* 2003). Positive correlations between egg weight, shell weight and shell thickness has also been reported by Farooq *et al.* (2001). This provides an indication for better prediction of eggshell weight and thickness from egg weight, width and length. While determining the qualities such as shell thickness, shell weight and the shell stiffness, either the compulsory of breaking of the egg or the need for the construction of some special mechanisms should be considered. Due to the said reasons, some methods are said to be applied for determining the shell stiffness (Poyraz, 1989). In some other researchers, the egg weight is said to have a direct relation with the eggshell quality which has a positive correlations with the shell thickness (Choi *et al.,* 1983; Stadelman, 1986). And shell weight (Choi *et al.,*1983; Poyraz, 1989). It is also mentioned by some other researchers that the shell thickness has an effect on the shell stiffness (Bus, 1982; Thompson *et al.,* 1981).

The research was carried out to predicting egg weight, shell weight, shell thickness, shell surface area, egg shape index, height of egg yolk and albumen length and yolk width using various egg traits as independent variables.

Materials and Methods

Totally 261 Japanese quail eggs collected in two sequential day were used for this research. Egg were obtained from 180 female quails, all at 15 weeks of age. The birds were housed as 1 male /2 female per cage at Department of Animal Science, Faculty of Agriculture, Akdeniz University. The quails were given quail diet "*ad libitum*" containing 24% protein and 2850 kcal ME/kg energy in the first 6 weeks period and later 21% protein and 2800 kcal ME/kg energy. A lighting schedule of 12 h light/day was applied. During the research, 0.01 g sensitive electronic scale was used for weighing the eggs; a compass sensitive to 0.01 mm was used for measuring the length, width, yolk diameter, albumen length of the eggs; a table with a flat glass on it was used on which the eggs are broken; a 3-legged micrometer sensitive to 0.01mm was used for measuring the height of yolk and albumen and a micrometer sensitive to 0.01 was used for measuring the shell thickness. The collected eggs to be used in this research were numerated at first. Then, they were balanced in order to determine their weights. Later, the width and length of the egg were measured. After this process, the eggs were broken on table with a glass cover in order to measure yolk height, yolk diameter, albumen length and albumen height. The eggshells were washed under slightly flowing water so that albumen remains are removed. The washed eggshells were left to dry in the open air for 24 hours. Then, they were balanced together with the eggshell membrane. Finally, samples taken from sharp, blunt and equatorial parts were measured and the average shell thickness was obtained from the average values of these three parts (Tyler, 1961). The surface area, expressed as centimeters squared (cm^2), of each egg was estimated using the formula of Carter (1975), $3.9782 \times W^{.7056}$, where W is egg weight in grams. Shape index = egg width / egg length x 100.

Following model was used for prediction of egg weight, using egg length and width as independent variables in different cases;

$Y_{ij} = a + b_i X_i + e_{ij}$

Where, Y_{ij} :egg weight (g), a: the intercept, b_i: the regression coefficients, X_i : egg width and length (mm) and e_{ij}: The residual term.

A similar model was used for predicting other traits using egg weight, length and width as independent variables.

Results and Discussion

Predicting of egg weight from egg length and width: Egg weight was predictable with sufficient accuracy from egg width and length as association of both traits with weight of the egg was significant (P<0.01). Regression coefficient of the fitted model was 82.60%. Khurshid *et al.* (2003) reported significant and positive association of egg weight with egg length and width of Japanese quails and regression coefficient was calculated as 31.86%. Farooq *et al.* (2001) also reported positive association of egg weight with egg width and length of Fayumi eggs. Following equation was developed for predicting egg weight from egg length and width,

$Y = -21.658 + 0.828 (X_1) + 0.373 (X_2)$

Where; Y = will be predicted egg weight, (X_1) = the egg width, (X_2) = the egg length.

Predicting of eggshell weight from egg weight, egg length and width: The eggshell weight, shell thickness and eggshell stiffness are important egg traits that can't be exactly predetermined until and unless eggs are broken. However, prediction equations can be developed to get information about these traits without breaking eggs. Some researchers had focused on the studies related to the increasing of the stiffness of the eggshell, because the quality of the eggshell has a vital importance for the laying force, embryo growth and the chick quality (Altan *et al.,* 1998). In this study, eggshell weight was found significantly (P<0.01) and positively associated with egg length and egg weight providing a good ground for predicting eggshell weight. But, the egg width has no significant effect on the eggshell weight. Adjusted R^2 of the fitted model was 50.70%. Khurshid *et al.* (2003) reported significant and positive association of eggshell weight with egg length and width of Japanese quails and regression coefficient was calculated as 7.01%. Following equation can be effectively used for predicting eggshell weight from egg width and egg weight;

$Y = 0.573+0.01532 (X_3) + 0.0238 (X_4)$

Where; Y = will be predicted eggshell weight; (X_3) = egg length; (X_4) = egg weight.

Predicting of eggshell thickness from egg weight, egg length and width: The eggshell thickness was predictable with accuracy (P<0.01) from egg length. The egg width and egg weight have no significant effects on the eggshell thickness. In this study, adjusted R^2 of the fitted model was 5.40%. But, Farooq *et al.* (2001), Khurshid *et al.* (2003) and Gulnavaz (2002) also reported significant association of eggshell thickness with egg width. Following equation was developed for predicting eggshell thickness from egg length;

$Y = 0.135 + 0.0031 (X_5)$,

Where; Y = will be predicted eggshell thickness, (X_5) = egg length.

Predicting of eggshell surface area from egg weight, egg length and width: Eggshell surface area was predictable with enough accuracy (P<0.01) from egg weight, egg length and width. Adjusted R^2 of the fitted model was 99.60%. Following equation was developed to predict eggshell surface area from egg weight, egg length and width.

$Y = 10.561-0.178 (X_6) -0.045 (X_7) + 1.535 (X_8)$,

Where; Y = will be predicted eggshell surface area, (X_6)

= egg width, (X_7) = egg length, (X_8) = egg weight.
Eggshell surface area can be predicted from egg weight ($P<0.01$). Adjusted R^2 of the fitted model was 99.40%. Following equation was developed for predicting eggshell surface area from egg weight;

$Y = 6.254 + 1.387\ (X_9)$,

Y = will be predicted eggshell surface area, (X_9) = egg weight.

Predicting of egg shape index from egg weight, egg length and width: Egg shape index was predictable with better accuracy from egg weight, egg width and length. Adjusted R^2 of the fitted model was 98.80%. Following equation was developed to predict egg shape index from egg weight, egg length and width.

$Y = 0.78 - 0.00048\ (X_{10}) + 0.0311\ (X_{11}) - 0.0241\ (X_{12})$,

Y = will predicted egg shape index, (X_{10}) = egg weight, (X_{11}) = egg width, (X_{12}) = egg length.

Egg shape index can also be predicted from egg width and length and Adjusted R^2 of the fitted model was 98.80%. Following equation was developed to predict egg shape index from egg length and width.

$Y = 0.79+0.0307\ (X_{13})\ -0.02423\ (X_{14})$,

Y = will predicted egg shape index, (X_{13}) = egg width, (X_{14}) = egg length.

Predicting of albumen length from egg weight, egg length and width: Albumen length was predictable with enough accuracy ($P<0.01$) from egg length and width. Egg weight has no significant effect on the albumen length. Adjusted R^2 of the fitted model was 25.30%. Following equation was developed to predict albumen length from egg length and width.

$Y = -53.843 + 2.712\ (X_{15}) + 1.376\ (X_{16})$,

Y = will predicted albumen length; (X_{15}) = egg width; (X_{16}) = egg length.

Predicting height of yolk from egg weight, egg length and width: Height of yolk was predictable with accuracy from egg width. Because, egg length and egg weight have no significant effect on height of yolk. Adjusted R^2 of the fitted model was 46.50%. Following equation was developed to predict height of yolk from egg width.

$Y = 2.908 + 0.261\ (X_{17})$,

Y = will predicted height of yolk; (X_{17}) = egg width

Predicting width of yolk from egg weight, egg length and width: Albumen length was predictable with enough accuracy ($P<0.01$; $P<0.05$) from egg weight, egg length and width. Adjusted R^2 of the fitted model was 79.40%. Following equation was developed to predict width of yolk from egg weight, egg width and length.

$Y = -4.406 + 0.824\ (X_{18}) + 0.195\ (X_{19}) + 0.168\ (X_{20})$

Y = will predicted width of yolk; (X_{18}) = egg width, (X_{19}) = egg length; (X_{20}) = egg weight.

As a result, the egg weight was enough predictable when egg width and egg length were used as independent variables, however, egg length and egg width can be used individually for predicting of egg weight. The eggshell weight was predictable with sufficient accuracy from egg length and egg weight. But, egg width has no significant effect on eggshell weight. Eggshell thickness was predictable with sufficient accuracy from egg length. In this study, egg width and weight have no significant effect on eggshell thickness. Eggshell surface area was predictable with sufficient from egg width, length and weight. Also, eggshell surface area can be individually predictable enough from egg weight. Egg shape index was predictable with better accuracy from egg weight, egg width and length. It could also be predicted from egg width and length. Also, albumen length was predictable with enough accuracy ($P<0.01$) from egg length and width. But, egg weight has no significant effect on the albumen length. Height of yolk was predictable with accuracy from egg width. Because, egg length and egg weight have no significant effect on height of yolk. Albumen length was predictable with enough accuracy ($P<0.01$; $P<0.05$) from egg weight, egg length and width. The egg weight, width and length have no significant effect on albumen height, albumen width, haugh unit, yolk index and albumen index. So, equation could not be developed to predict from egg weight, width and length for albumen height, albumen width, haugh unit, yolk index and albumen index traits.

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