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Prediction of Albumen Weight, Yolk Weight, and Shell Weight As Egg Weight in Japanese Quail Eggs

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Summary: This study was conducted to determine the most adequate models for defining the correlation between the egg weight and the albumen, yolk and shell weights as well as pointing out the practicability options for determining the egg weight as an estimator of the egg shell, egg yolk and the egg albumen weights in the quail eggs. In this experiment, a total of 175 eggs were collected in 3 consecutive days from 72 female quails, aged 20 weeks. The birds were housed as 1 male/3 female per cage of 40x30x30 cm at Quail Research unit of the Department of Zootechnia, Faculty of Veterinary Medicine, and Firat University. The highest phenotypic correlation was determined between egg weight and albumen weight (0.94). The least phenotypic correlation was determined between egg weight and shell weight (0.61). Coefficients of determinations (R^2) indicated that quadratic, logistic and exponential models showed the better fit to explain the relationship between the egg weight and the albumen weight respectively. On the other hand, the best models used in defining of the correlation between the egg weight and the yolk weight are quadratic, linear, logistic, and exponential models. As for the relationship between the egg weight and the shell weight; quadratic, linear, logistic, and exponential models were mostly accurate. As a result of the research, it was determined that it was possible to use the egg weight as the estimator of the albumen and the yolk weights by using a suitable model, however, it was not fully possible for the determination of the shell weight.

Key Words: Egg weight, egg quality characteristics, model, quail.

Japon Bıldırcını Yumurtalarında Yumurta Ağırlığı Kullanılarak Ak Ağırlığı, Sarı Ağırlığı ve Kabuk Ağırlığının Tahmin Edilmesi

Özet: Bu araştırma, bıldırcın yumurtalarında ak ağırlığı, sarı ağırlığı ve kabuk ağırlığının belirlenmesinde yumurta ağırlığının bir tahminci olarak kullanılabilme imkanının tespiti ve yumurta ağırlığı ile ak, sarı ve kabuk ağırlıkları arasındaki ilişkiyi açıklamak için en uygun modellerin tespiti amacıyla yapılmıştır. Ard arda üç gün süreyle toplanmış, toplam 175 bıldırcın yumurtası bu araştırmada kullanılmıştır. Yumurtalar 20 haftalık yaştaki 72 bıldırcından elde edilmiştir. Araştırmada yumurta ağırlığı ile ak (0.94), sarı (0.77) ve kabuk (0.61) ağırlıkları arasında tespit edilen fenotipik korelasyonlar istatistiki olarak önemli bulunmuştur ($P<0.01$). Araştırmada elde edilen determinasyon katsayıları (R^2) yumurta ağırlığı ve ak ağırlığı arasındaki ilişkiyi açıklamak için sırasıyla quadratic, logistic ve exponential modellerin daha uygun olduğunu göstermiştir. Yumurta ağırlığı ve yumurta sarı ağırlığı arasındaki ilişkiyi açıklamak için en uygun modeller ise sırasıyla quadratic, linear, logistic ve exponential modeller olmuştur. Yumurta ağırlığı ile kabuk ağırlığı arasındaki ilişki ise sırasıyla quadratic, linear, logistic ve exponential modeller tarafından en doğru şekilde açıklanmıştır. Sonuç olarak, bıldırcın yumurtalarında uygun bir model kullanarak ak ve sarı ağırlıklarının belirlenmesinde yumurta ağırlığının bir tahmin edici olarak kullanılmasının mümkün olduğu ancak bu durumun kabuk ağırlığı için yeterince güvenli olamayacağı saptanmıştır.

Anahtar Kelimeler: Yumurta ağırlığı, yumurta kalite özellikleri, model, bıldırcın.

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Introduction

Poultry have an important place among animal protein sources. In the recent 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 become widespread[2].

The egg productivity and the internal and external quality traits of the egg are the significant factors for allowing the continuity of breeding as well as restricting the productivity traits of the future generation[16], the albumen both protects the embryo against microorganisms until growing of the immune system and allows a source of nutrition. On the other side, the yolk meets the feeding needs of the chicks in the first days, and the eggshell protects the embryo against external effects[1]. Therefore, the external and internal quality traits of the eggs are significant for affecting the hatchability of fertile eggs, chick quality and growth of the chicks[5,6,10,15].

The quality traits of the eggs determine the prices directly in the commercial flocks. In the egg processing enterprises, the weight of eggshell, albumen and yolk that form the egg as well as their rates affect the amount and price of the product[1]. Most of the egg quality traits are affected by various factors such as the genetic structure of the flocks, feeding, health, flock age, housing, storage period and conditions[1,12,16]. Either the compulsion of breaking of the egg or the need for construction of some special mechanisms are considered in the determination of some traits such as the albumen weight, yolk weight, shell thickness, shell weight and the shell stiffness. In the recent years, the studies were related to the determination of the relations between such traits. It has been indicated that the re is significant genotypic and phenotypic correlation between the internal and external quality traits of the eggs[6,9,11]. With reference to these results, the researchers reported that the egg weight would be used as an estimator (which has high and significant correlations with the said traits) in determining some quality traits such as albumen, yolk and shell weights (Yannakopoulos and Tserveni-Gousi 1986, Singh and Panda 1987, Narushin et al. 2001).

Ar et al. (1979) applied allometric functions for the estimation of different egg internal quality traits using the data related to the egg weight. Narushin (1994) suggested various empirical equations for the indirect estimation of the egg weight with the albumen, yolk and shell weight in different poultry species. Narushin et al. (2001) used linear, quadratic, logistic, s-model, allometric, exponential and logarithmic models for defining the practicability in the estimation of egg weight with the albumen, yolk and shell weights at the quail eggs, and for referring to the correlation between the egg weight and such traits in order to determine whether which models were adequate.

This study was carried out in the purpose of determining the most adequate models for defining the correlation between the egg weight and the albumen, yolk and shell weights as well as pointing out the practicability options for determining the egg weight as an estimator of the egg shell, egg yolk and the egg albumen weights in the quail eggs.

Materials and Methods

In this study, a total of 175 eggs were collected in 3 consecutive days from 72 female quails, aged 20 weeks. The birds were housed as 1 male/3 female per cage of 40x30x30 cm at Quail Research unit of the Department of Zootechnia, Faculty of Veterinary Medicine, and Firat University. The Japanese quail were raised in floor pens and fed with conventional starter and grower diets until they reached 6 wk of age. In the trial period, the quails were given quail diet *ad libitum* containing 21% protein and 3000 kcal ME/kg energy in the first 6 weeks period, and later 17% protein and 2750 kcal ME/kg energy. A 1ighting schedule of 16 h light/day was applied. During the experiments, an electronic scale at 0.001 gr. sensitivity was used for weighing the albumen, yolk and shell weights of the eggs. After the weighing process, the eggs were broken and accurately divided into three components: shell, yolk, and albumen. The yolk and albumen were weighed immediately after breaking; the shell was dried at the room temperature and weighed after water evaporation from the solid substance (Narushin et al. 2001).

The phenotypic correlation values related to the internal and external quality traits of the eggs are determined by the Pearson Correlation Analysis (Snedecor and Cochran 1980). The correlation between egg weights and albumen, yolk and shell weights were fitted to the several models. In this study, following mathematical models by reported Narushin (2001), as commonly used models, were applied in order to make mathematical definitions of different biological operations.

Linear $\hat{Y} = b_o + b_1 X$

Quadratic $\hat{Y} = b_o + b_1 X + b_2 X^2$

Logarithmic $\hat{Y} = b_o + (b_1 . \ln(X))$

S-model $\ln(\hat{Y}) = b_o + (b_1 / X)$

Logistic $\ln(1/\hat{Y} - l/u) = \ln(b_o + (\ln(b_1). X))$

Exponential $\ln(\hat{Y}) = \ln(b_o) + (b_1 X)$

Where b_o, b_1 are proportionality coefficients; u is the upper boundary value.

All statistical data and selection of the best model and model parameters were calculated by SPSS 11.5 (SPSS for windows 1999).

Results

The descriptive statistics obtained in this study is shown in Table I, and the phenotypic correlations between the egg weight and albumen, yolk and shell weights is shown in Table II. The mean values (± Standard Error Mean) belonging to the egg weight, albumen, yolk and shell weights are obtained respectively as 11.29 g, 6.76 g, 3.69 g and 0.845 g. The CV's are almost at the same values, and the highest one is the shell weight (9.59 %). The highest phenotypic correlation was determined between egg weight and albumen weight (0.94). The least phenotypic correlation was determined between egg weight and shell weight (0.61).

Table I. Descriptive statistics of quality traits at quail eggs

Tablo I. Bıldırcın yumurtalarının kalite özelliklerine ait tanımlayıcı istatistikler

Traits (n=175)	Mean ± Standard Error Mean (SEM)	Minimum	Maximum	Coefficient of Variation (CV) %
Egg weight	11.291±0.06	9.10	13.50	7.51
Albumen weight	6.755± 0.05	5.430	8.180	8.97
Yolk weight	3.691 ±0.02	2.750	4.400	8.07
Shell weight	0.845 ±0.006	0.610	1.060	9.59

Table II. Correlation coefficients (r) for egg weight vs egg parameters

Tablo II. Yumurta özellikleri ile yumurta ağırlığı arasındaki korelasyonlar (r)

Correlation pairs	r
Egg Weight-Albumen Weight	0.94**
Egg Weight- Yolk Weight	0.77**
Egg Weight- Shell Weight	0.61 **

**: P<0.0l

Models regression coefficients and determination (R^2) are shown in Tables III-V and the regression curves are plotted in Figures 1-6.

Table III. Prediction equations and coefficients of determination (R^2) relating to egg weight and albumen weight

Tablo III. Yumurta ağırlığı ve ak ağırlığı arasındaki determinasyon katsayısı (R^2) ve tahmin denklemi

Egg Weight & Albumen Weight		R^2
Linear	$\hat{Y}$= 2.3887 + 1.3179 X	0.885
Quadratic	$\hat{Y}$= 7.5927 - (0.2424 X) + 0.1160 X^2	0.889
Logarithmic	$\hat{Y}$= -5.4010 + (8.7567 . ln(X))	0.878
S-model	ln($\hat{Y}$) = 3.1877 + (- 5.1353 / X)	0.876
Logistic	ln(l/ $\hat{Y}$ - 1/u) = ln (0.1959 + (ln (0.8895).X))	0.886
Exponential	ln($\hat{Y}$) = ln(5.1058) + (0.1171.X)	0.886

Table IV. Prediction equations and coefficients of determination (R^2) relating to egg weight and yolk weight

Tablo IV. Yumurta ağırlığı ve sarı ağırlığı arasındaki determinasyon katsayısı (R^2) ve tahmin denklemi

Egg Weight & Yolk Weight		R^2
Linear	$\hat{Y}$= 3.1954 + 2.1929 X	0.593
Quadratic	$\hat{Y}$= 12.6076 - (2.9558 X) + 0.6995 X^2	0.606
Logarithmic	$\hat{Y}$= 1.0178 + (7.8855 . ln(X))	0.578
S-model	ln($\hat{Y}$) = 3.0940 + (- 2.4674 / X)	0.556
Logistic	ln(l/ $\hat{Y}$ - 1/u) = ln (0.1817 + (ln (0.8237).X))	0.588
Exponential	ln($\hat{Y}$) = ln(5.5027) + (0.1939.X)	0.588

Table V. Prediction equations and coefficients of determination (R2) relating to egg weight and shell weight

Tablo V. Yumurta ağırlığı ve kabuk ağırlığı arasındaki determinasyon katsayısı (R2) ve tahmin denklemi

Egg Weight & Shell Weight		R^2
Linear	$\hat{Y}$= 5.9338 + 6.3427 X	0.368
Quadratic	$\hat{Y}$= 11.5143 - (6.8720 X) + 7.7518 X^2	0.376
Logarithmic	$\hat{Y}$= 12.2037 + (5.2618 .ln(X))	0.358
S-model	ln($\hat{Y}$) = 2.8710 + (- 0.3764 / X)	0.338
Logistic	ln(l/ $\hat{Y}$ - 1/u) = ln (0.1422 + (ln (0.5572).X))	0.361
Exponential	ln($\hat{Y}$) = ln(7.0328)+(0.5572.X)	0.361

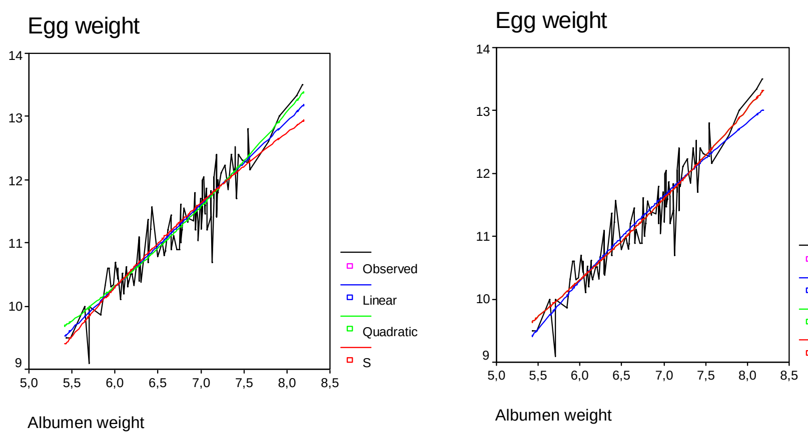

Figure 1-2.
Regression curves of albumen weight in relation to egg weight

Şekil 1-2.
Yumurta ağırlığı ile ak ağırlığı arasındaki regresyon eğrileri

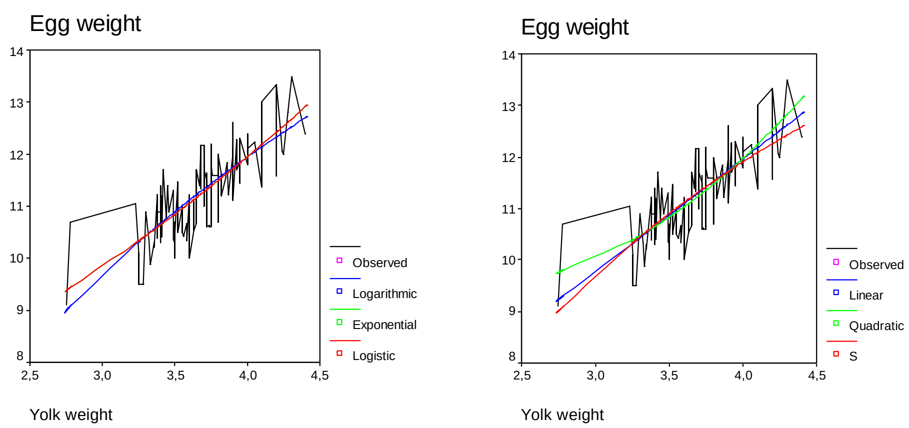

Figure 3-4.
Regression curves of yolk weight in relation to egg weight

Şekil 3-4.
Yumurta ağırlığı ile sarı ağırlığı arasındaki regresyon eğrileri

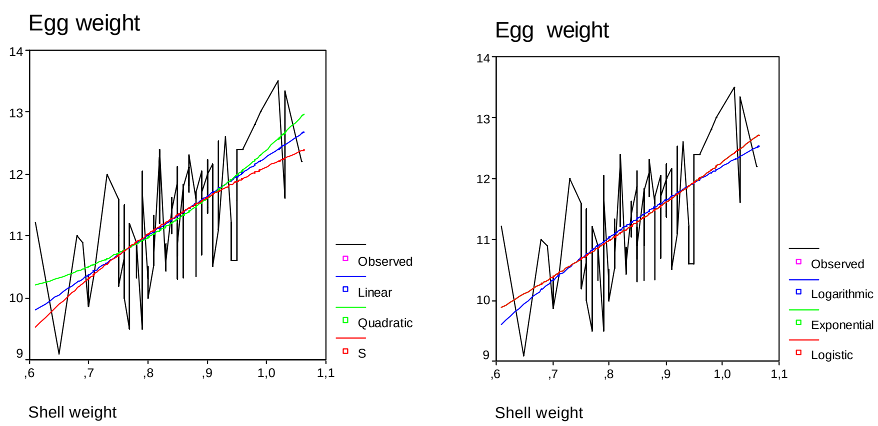

Figure 5-6.
Regression curves of shell weight in relation to egg weight

Şekil 5-6.
Yumurta ağırlığı ile kabuk ağırlığı arasındaki regresyon eğrileri

Discussion

In this study, the phenotypic correlations determined between the egg weight and the albumen, yolk and shell weights were found statistically significant (P<0.01). These findings are in consistent with the results of some researchers (Pandev et al. 1984, Poggepel 1986, Narahari et al. 1988, Narushin et al. 2001).

The determination of the highest correlation values between the egg weight and the albumen weight indicated that the value of the egg weight is quite much related to the changes in the albumen weight and that such changes are rather determinative. This result is similar to the significant positive correlation (0.97) finding determined between the egg weight and the albumen weight of the quail eggs in the researches of some researchers (Narushin et al. 2001).

Coefficients of determinations (R^2) indicated that quadratic, logistic and exponential models showed the better fit to explain the relationship between the egg weight and the albumen weight respectively. On the other hand, the best models used in defining of the correlation between the egg weight and the yolk weight are quadratic, linear, logistic, and exponential models. As for the relationship between the egg weight and the shell weight; quadratic, linear, logistic, and exponential models were mostly accurate. Similar to the above findings, in the research made by Narushin et al. (2001) on 35 quail eggs, the correlation between the egg weight and the albumen weight was presented respectively with the quadratic, logistic exponential models, and the correlation between the egg weight and the albumen weight was given respectively with the quadratic, linear and allometric models.

However, there is a difference between the model s that were determined for defining the correlation between the egg weight and the shell weight and the model except for the quadratic model mentioned by Narushin et al. (2001) among the s-model, quadratic and logarithmic models. This is probably because of the different number of eggs used in the analysis as well as their variations of the eggshells (as the variation coefficient of the eggshell was 9.59% in this research, it was 16.9% in the other research).

Conclusion

As a resu1t of the re search, it was determined that it was possible to use the egg weight as the estimator of the albumen and the yolk weights by using a suitable model, however, it was not ful1y possible for the determination of the shell weight. Consequently, it was considered that additional studies are required for the multiple regression analysis including non-destructively measured egg traits for the determination of the eggshell weight.

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