PREDICTION OF JAPANESE QUAIL EGG WEIGHT USING EGG COMPONENTS AS REGRESSORS

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ABSTRACT
This study was conducted on one hundred freshly laid eggs from Japanese quails with the purpose of predicting quail egg weight (EW) from some internal and external egg components, and also to have accurate and reliable models, for the prediction of egg weight without the use of sensitive scale. The following external (egg weight, egg width, egg length, shell thickness) and internal (yolk width, yolk length, albumen height and Haugh unit) components were measured and the level of relationships between them were determined. Level of affinity between egg components measured ranged from 0.054(Haugh unit vs. shell thickness) to 0.559 (Haugh unit vs. albumen height). Descriptive statistics for the eight egg components considered were computed. Intercept and slope of regression between variables were determined. Generated values were used in multiple, double and simple linear regression equations, respectively. A total of ten prediction equations comprising three multiple, six double and nine simple linear resulted from the data generated. All the equations developed can be used in egg type quail operations. Each prediction equation with egg weight as the dependent variable will assist poultry breeders and farmers in particular in determining the precise egg weight of eggs laid by birds on the farm.
Key words: Prediction, dependent variable, egg components, models, Japanese quail

Introduction

Egg is a major poultry product and mainly composed of albumen, yolk and egg shells (Abanikannda and Leigh, 2007). Compared to other sources of animal protein, egg is more affordable by the common man which gives poultry more advantage over other livestock. The eggs are cheap and readily available sources of protein in developing countries cannot be overemphasized and the contribution of major constituents of egg i.e. albumen and yolk to dietary intakes of humans have been well documented (Orji *et al*., 1998; Khurshid *et al*., 2005). Although chicken eggs are currently most commonly eaten by humans, the eggs from other birds are also used for daily consumption. For example Japanese quail eggs are gaining popularity in Europe and America, ostrich eggs in South Africa (Horbañczuk *et al.*, 2008). Quail eggs are the eggs laid by various species of quail, which are in the order *Galliformes*. Quail are mid-sized birds found in Europe, North Africa, the southern United States and some parts of Asia. (Horbañczuk *et al.*, 2008). Quail eggs are much smaller than average duck chicken egg, widely consumed and sold as novelty foods around the world and they range from white to brown in colour and mottled (black and brown spots). The weight of an egg is a direct proportion of albumen, yolk and shell it contains (Pandey *et al.*, 1986). Egg weight is an important egg trait, which influences egg quality as well as grading (Farooq *et al.*, 2001). In the egg processing enterprises, the weight of eggshell, albumen and the yolk that form the egg affect the amount and price of the product (Altan *et al.,1998*). In the context of egg production, the quality of an egg, which is not only known as the basic product in poultry activities by breeders, but also provided cheaply to consumers, is dependent on internal (albumen weight and yolk weight) and external (shell weight) quality traits. The use of prediction equations had been used by some researchers in poultry breeding, Abanikannda *et al*., (2007); Galal (2007); Raji *et al*., (2008) and Olowofeso (2009) carried out the development of some prediction equations which are useable in poultry production. Egg weight was easily predictable from egg length and width as positive association among these traits existed (Farooq *et al.,* 2001). This provides an indication for prediction of egg weight from both external (Egg width, egg length, shell thickness) and internal (yolk width, yolk height, albumen height and haugh unit) egg components. Prediction of egg weight based on the level of relationship between both external and internal components means there is a need to compute correlation and regression estimates between these components.

Forecasting of egg weight without recourse to sensitive electronic scale has been a serious problem in egg production enterprise. The high cost of sensitive electronic scale has made it imperative to develop very simple and reliable mathematical relations for the prediction of egg weight based on the level of relationship between external and internal egg components (Olowofeso *et al.,* 2013).

Therefore, the objectives of this study were to estimate the relationship between internal and external components of quail eggs and to develop some reliable prediction equations to estimate Japanese quail's egg weight using both external and internal components.

Materials and methods

This study was carried out at the Quail unit, Obafemi Awolowo University Teaching and Research Farm, Ile-Ife, Osun state, Nigeria which lies between latitude $7^0 27^{'} 59.99^{''}$N and longitude $4^0 33'59.99''$E (Androni TS GPS). 400 day old chicks were gotten from National Veterinary Research Institute Substation, Irewolede Local Government, Ikire and were taken to the Teaching and Research farm, where they were brooded from day old till 4 weeks of age. The quails were raised under favourable environmental condition and were fed *ad libitum* with quail's diet containing 24% protein and 2850 kcal ME/kg energy in the first 4 weeks period and later 20% protein and 2800 kcal ME/kg energy. These birds started laying at the age of 5 weeks. One hundred freshly laid quail eggs used for this study were collected in the morning from the Quail unit of the Teaching and Research Farm, which were obtained from one hundred and ninety female quails at 9 weeks of age. These freshly laid eggs were washed with clean water and dried with towel to remove dirts and contaminants from the shell. They were arranged on plastic egg trays, placed under fans to blow away tiny particle(s) which might be attached to the eggshell.

Data Collection

Data were collected on egg weight , egg length, egg width, albumen height, yolk height, yolk width, shell thickness and haugh unit to determine the relationship between the internal and external components and to develop prediction equations to estimate egg weight using both components.

Statistical Analysis

Correlation coefficient (R^2) and regression coefficient (b) between variables were estimated with SAS software (2002). Similarly, the prediction equations were developed using the linear function earlier defined by Glover and Mitchell (2001) and depicted as: $Y= (y- bx) + bX \Rightarrow Y= y + b(X-x)$

Where X and Y represent the independent and dependent variables respectively. When the values of these parameters were incorporated into the linear function defined above, a total of fifteen prediction equations were generated. Haugh unit (HU) was computed using: HU= 100 log $(H+7.57- 1.7W^{0.37})$.

Results and Discussions

Descriptive statistics for the egg components measured is shown on table 1. The mean weight of quail egg (9.13g) in this study was lower than 11.28, 11.4, 10.2, and 10.34g reported by kul and seker (2004) and Dudusola (2010) and higher than 7.041g reported by Mudhar (2011). Mean egg weight, egg length, egg width, albumen height, , yolk height, yolk weight, shell thickness and Haugh unit were 9.13g, 2.97, 2.33, 0.57, 1.14, 2.18cm, 0.13mm and 100.57 respectively.

Table 1: Internal and external components of Japanese quail eggs

Parameters	Mean±SEM
Egg weight	9.13±0.06
Egg length	2.97±0.01
Egg width	2.33±0.05
Albumen height	0.57±0.09
Shell thickness	0.13±0.03
Yolk height	1.14±0.08
Yolk width	2.18±0.01
Haugh unit	100.57±0.01

SEM= Standard error of the mean

The level of affinity between egg components considered is shown on table 2. Egg weight correlate positively and significantly with egg width, egg length, yolk height and yolk width which implies that as each of these components increases, egg weight also increases. The correlation between Egg Weight and Egg Length (0.813), Egg Width and Egg Length (0.469) and Egg Weight and Egg Length (0.785) in this study were similar to Kul and Seker (2004) who reported correlation of 0.80, 0.76 and 0.35 respectively. The correlation between egg width and haugh unit was significant but negative. Egg width correlate significantly and positively with egg length but negatively with haugh unit. This means as egg length increases, egg width and haugh unit increase but egg width decreases. There was a positive correlation between egg length and yolk height and also with yolk width which was significant. The negative correlation between shell thickness and yolk width was significant. The correlation between albumen height and haugh unit was positive and significant and the correlation coefficient between these components for Japanese quail egg obtained in this study was not significantly different from the value reported for these variables for chicken by Olowofeso *et al*., (2013). Lastly, there was negative correlation between yolk width and haugh unit which was significant which implies that as haugh unit increases, the yolk width also decreases.

Table 2: Levels of affinity between all egg components

Traits	EW	EWD	EL	ST	YH	AH	YW	HU
EW		0.81*	0.79*	0.00007	0.25**	0.25**	0.49*	-0.67*
EWD			0.47*	-0.067	0.12	0.24	0.49*	-0.51*
EL				-0.004	0.29*	0.17	0.46	-0.54
ST					-0.08	-0.07	-0.20**	-0.05

YH	0.16	0.09	-0.097
AH		0.13	0.56
YW			-0.32*
HU			

*= Significant at p< 0.0001, **= Significant at p< 0.05; EW- Egg weight, EWD- Egg width, EL- Egg length, ST- Shell thickness, YH- Yolk height, AH- Albumen height, YW- Yolk width, HU- Haugh unit.

Ten prediction equations developed based on the data generated in this study are shown on table 3. The equations were ranked based on Akiake Information Criterion (AIC) and Cp statistics which are used for selecting the most appropriate models that best predict the egg weight. Thirty nine prediction equations were initially generated of which the best ten were selected using AIC. It was reported in the literature that these generated equations are of immense importance to poultry farmers especially those with interest in egg production (Olowofeso *et al*., 2013). The ten prediction equations for estimating quail's egg weight from egg components can be used by poultry breeders and farmers alike, however, use of single trait in *in vivo* prediction is usually imprecise and produces lower coefficient of determination (R^2) according to Wawro (1990) and Raji *et al.*, (2008), respectively. Based on the above assertion, multiple regression equations may be used in predicting desired variable(s) at a particular instance in an egg type quail operation.

Table 3: Ten prediction equations developed for estimating Japanese quail's egg weight

Variable	Prediction equations for quail egg weight	Rank
$Y_{EW(EL,AH,ST,YH,YW)}$	-6.06+4.12EL+0.73AH+1.03ST+0.26YH+0.98YW	I
$Y_{EW(EL,AH,YH,STYW)}$	-5.91+4.18EL+0.76AH+0.96ST+0.96YW	II
$Y_{EW(EL,AH,YH,YW)}$	-5.84+4.16EL+0.72AH+0.22YH+0.91YW	III
$Y_{EW(EL,AH,YW)}$	-5.72+ 4.21EL+0.74AH+0.90YW	IV
$Y_{EW(EL,ST,YH,YW)}$	-6.03+4.19EL+0.92ST+0.36YH+1.01YW	V
$Y_{EW(EL,YH,YW)}$	-5.83+4.23EL+0.32TH+0.95YW	VI
$Y_{EW(EL,ST,YW)}$	-5.81+ 4.27EL+0.83ST+0.99YW	VII
$Y_{EW(EL,YW)}$	-5.66 +4.30EL+0.93YW	VIII
$Y_{EW(EL,AH,ST,YH)}$	-5.16+4.59EL+0.78AH+0.28ST+0.17YH	IX
$Y_{EW(EL,AH,ST,YH)}$	-5.80+4.63EL+1.37AH-0.65ST+0.13YH	X

EW- egg weight, EL- egg length, AH- albumen height, ST- shell thickness, YH- yolk height, YW- yolk width.

Conclusion and recommendation

It can be concluded from the study that the correlation between egg weight and egg width, egg weight and egg length were higher compared to others, meaning that they contributed more to the egg weight. Also, a total of ten prediction equations were developed for the estimation of quail's egg weight in this study, the first three multiple regression equations are of outmost importance in predicting the quail's egg weight at all times. Other equations developed, that is equations IV through X can also be used in the absence of sensitive electronic scale for egg weight determination.

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