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The Correlation between Egg Internal Components and Egg Dimensions Detected by Using Image Processing in Japanese quail

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Abstract

THE current study was done in the animal production department, college of agriculture, University of Kirkuk from 25/9/2022 until 15/2/2023, to study the effect of internal egg traits on the egg axis by using image-processing program. Two hundred eighteen fertilized eggs were collected from the Japanese white quail flock. After collecting the eggs, visual studio 2017 was used to getting the W and Y-axis. As well as the data was analyzed by using general linear model (GLM) with SPSS v18 program to find the effect of egg external measurements on the studied traits. Pearson's coefficients of correlation (r) among egg weight and the internal egg traits were estimated. It was concluded that the effect of the albumin weight on the W and Y-axis was same, but the yolk weight effect on the Y-axis more than W-axis.

Keywords: Image processing, Egg, Dimension, Quail.

Introduction

The study of egg traits has been a central focus in poultry science due to their importance in breeding, nutrition, and commercial production. Over the past decades, researchers have extensively investigated both the quality and quantity aspects of eggs, particularly in species such as chickens, ducks, and quails [1–4]. Egg quality, in general, is assessed through both external and internal characteristics. These characteristics are often influenced by a variety of biological and environmental factors, including genetic makeup, feathering patterns [5], shank feathering [6], genetic lineages [7–9], species differences [10, 11], and environmental conditions such as temperature, lighting, and nutrition [12–14]. External egg traits including egg length, breadth, shell thickness, volume, shape index, and surface area have been systematically measured and analyzed in multiple studies [15–17]. These traits are not constant; rather, they are influenced by several factors such as the age of the bird [18], its genotype [19–21], oviposition time [22], and the interaction between these variables [23]. For instance, eggs laid earlier in the day or at certain stages of the hen's life cycle may differ significantly in shape and size compared to others. These changes can directly influence the overall egg shape index, which is a crucial metric in evaluating egg form and structure.

Internal egg traits, such as the weight and volume of the yolk and albumen (egg white), as well as their respective proportions, are also important quality indicators. These components have been widely studied in different poultry species [1, 10, 24]. The balance between yolk and albumen not only affects nutritional value but also plays a role in embryo development during incubation. The relationship between internal and external traits is intricate and often interdependent.

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The egg shape index, defined as the ratio of egg breadth to length multiplied by 100, has often been used as a reliable parameter for assessing egg geometry. Studies have shown that both internal contents and external dimensions significantly influence this index. Moreover, the formation of egg shape is largely governed by the hen's physiological and health status, including factors such as reproductive tract function and hormonal regulation. Therefore, understanding how internal components impact the overall egg shape provides deeper insights into poultry biology and egg production.

Traditionally, the analysis of egg traits relied on manual measurements and regression-based statistical methods [25]. However, with advancements in technology, digital tools and image processing techniques have emerged as precise and efficient alternatives for morphological analysis [26]. These methods allow for the accurate measurement of egg axis dimensions and shape indices by capturing high-resolution images and extracting quantitative data through specialized software.

The current study was designed to explore the relationship between internal egg traits and external egg dimensions in Japanese quail, using advanced image processing techniques. By utilizing image analysis software, the experiment aimed to quantify various egg parameters, including yolk and albumen proportions, egg length, breadth, and shape index. The purpose was to determine whether specific internal components correlate significantly with external egg measurements and overall egg shape. This approach not only enhances the accuracy of trait assessment but also contributes to the development of non-invasive, rapid methods for evaluating egg quality in breeding and production programs. Such findings are expected to be valuable in genetic selection, productivity improvement, and quality control in the poultry industry.

Material and Methods

The current study was done in the animal production department, college of agriculture, University of Kirkuk from 25/9/2022 until 15/2/2023. Two hundred eighteen fertilized eggs were collected from the Japanese quail flock. After collecting the eggs were numbered and photo was taken by using digital camera and weighted by using electronic balance with (0.001) g sensitivity. The egg photos were analyzed by using visual studio 2017 according to the algorithm below processed the egg images (Fig 1):

1. Remove the background.
2. Select the border of the egg.
3. Find the center of the egg.
4. Divided the upper egg part of the Y-axis to equal 8 spaces.
5. The variable W= 4^{th} part of the divided upper Y.
6. Divided the lower part of the Y-axis to equal 8 spaces.
7. The variable Y=5^{th} part of the divided lower Y.

The external egg traits were measured by using digital electronic calliper with (0.01) mm sensitivity. Then eggs were broken to weight the yolk, and albumin. The yolk weight was measured by using electronic balance with (0.001) g sensitivity, and the albumin weight was measured by the equation below: Albumin weight = egg weight – (yolk weight + shell weight)

Results

The descriptive analysis of the internal and external egg traits concerning mean, standard error, standard deviation, coefficient of variation, minimum, and maximum is shown in table 1. The mean of the albumin, and yolk weight were (4.73, 3.03) g respectively, and the egg length, and breadth were (31.98, 24.87) mm respectively. The W, and Y were (28.41, 23.48) mm respectively. The coefficients of variation were (10.99, 11.55, 4.19, 3.53, 4.22, 5.02) for the albumin weight, yolk weight, egg length, egg breadth, W2-axis, Y2- axis respectively.

The correlation among the studied traits was highly positive correlated. Concerning the correlation of the axis with internal egg traits, the W-axis was equal correlated with the albumin weight, yolk weight (0.859, 0.860) respectively. And the Y-axis was correlated highly with albumin weight then yolk weight (0.730, 0.560) respectively. The correlation between the external egg traits and the axis The W-axis was highly correlated with the egg breadth (0.955), and less with egg length (0.671). And also the Y-axis was highly correlated with egg breadth rather then egg length (0.780, and 0.296) respectively.

Discussion

The fluctuation in the coefficient of the shape of the egg during the period of raising the bird for a certain age is caused by the chain of laying the egg, because the egg and its components are small at the beginning of the chain and begin to increase in size, which increases the weight of the yolk and white secreted [21]. In addition, [10] found that the percentage of yolk and white did not differ significantly between three strains of local Kurdish chicken when compared with commercial Isa brown chicken.

The increase of components weight of the egg leads to an effect on the length and breadth dimensions of the egg [18], as we found in the current experiment. Furthermore, the egg breadth coefficient of variation in the current study was low (3.53) because the trait effect by the genetic factor [5]. The W and Y-axis has a positive and highly

significant correlation with an increase in the weight of the albumin (0.859, 0.730) respectively, followed by the yolk with a medium correlation ratio (0.860, 0.560) respectively. This indicates that the (Y) in the egg is only due to the increased secretion of the albumin.

Conclusion

It was concluded tat the effect of the albumin weight on the W and Y-axis was same, but the yolk weight effect on the Y-axis more the W-axis.

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Declaration of Conflict of Interest

The authors declare that there is no conflict of interest.

TABLE 1. Mean, standard error, standard deviation, minimum, and maximum values of some the internal and external traits

Traits	Mean ± S.E.	S.D.	CV	Min.	Max.
Albumin weight	4.73±0.04	0.52	10.99	3.59	6.02
Yolk weight	3.03±0.03	0.35	11.55	2.15	4.12
Egg Length	31.98±0.11	1.34	4.19	28.29	35.24
Egg breadth	24.87±0.07	0.88	3.53	22.98	27.11
W2	28.41±0.10	1.20	4.22	25.94	31.36
Y2	23.48±0.10	1.18	5.02	21.02	26.44

S.E.= Standard error, S.D.= Standard deviation, CV= Coefficient of variation, Min.=Minimum, Max. = Maximum.

TABLE 2. The correlation of coefficient between the internal and external traits of Japanese quail eggs

	AW	YW	EL	EB	W2	Y2
AW	1					
YW	0.701***	1				
EL	0.754***	0.780***	1			
EB	0.886***	0.852***	0.635***	1		
W2	0.859***	0.860***	0.671***	0.955***	1	
Y2	0.730***	0.560***	0.296***	0.780***	0.700***	1

AW= Albumin weight, YW= Yolk Weight, EL= Egg Length, EB= Egg Breadth, W2= upper 4th axis, Y2= lower 5th axis.

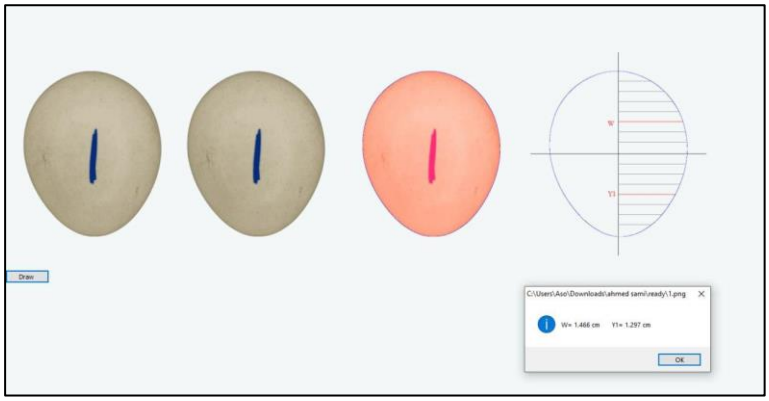

Fig. 1. Steps of detecting W and Y-axis. The data was analyzed by using general linear model (GLM) with SPSS v18 program to find the effect of egg external measurements on the studied traits. Pearson's coefficients of correlation ® among egg weight and the internal egg traits were estimated.

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العلاقة بين المكونات الداخلية للبيضة وأبعادها المكتشفة باستخدام معالجة الصور في السمان الياباني

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الملخص

أجريت الدراسة الحالية في قسم الإنتاج الحيواني، كلية الزراعة، جامعة كركوك، من 2022/9/25 إلى 2023/2/15، لدراسة تأثير الصفات الداخلية للبيض على محور البيضة باستخدام برنامج معالجة الصور. تم جمع 218 بيضة مخصبة من قطيع السمان الأبيض الياباني. بعد جمع البيض، تم استخدام Visual Studio 2017 للحصول على المحورين W و Y. كما تم تحليل البيانات باستخدام النموذج الخطي العام (GLM) مع برنامج SPSS v18 لمعرفة تأثير القياسات الخارجية للبيضة على الصفات المدروسة. تم تقدير معاملات ارتباط بيرسون (r) بين وزن البيضة والصفات الداخلية للبيضة. وخلصت الدراسة إلى أن تأثير وزن الألبومين على المحورين W و Y كان هو نفسه، ولكن تأثير وزن الصفار على المحور Y كان متماثلاً مقارنة بالمحور W.

الكلمات الدالة: معالجة الصور، البيض، الأبعاد، السمان.