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Using Principal Component Analysis to Characterize Egg Components in two Waterfowl Species

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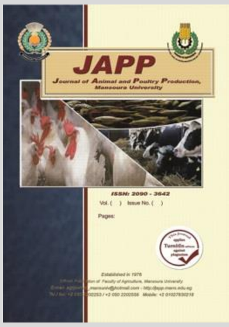

ABSTRACT

The present study was done in the laboratories of animal science department that belongs Sulaimani University. During June 2017 to February 2018, a total of (91) duck and (98) geese eggs were collecting from local farms in Sulaimani province to evaluate some external and internal traits. Eggs weighed individually by using electronic balance, and Egg length and breadth of each egg was measured by using digital Vernier caliper. after breaking the eggs, yolk, albumin and shell weight was recorded. Moreover, Yolk diameter was estimated. Mean, standard error, minimum and maximum of the external and internal traits for both species were calculated using the descriptive analysis of SPSS. Person's coefficients of correlation (r) among egg weight, external and internal egg traits were estimated. From the correlation matrix, data were generated for the principal component analysis. Anti-image correlation, Kaiser-Meyer-Olkin measures of sampling adequacy rotation component matrix, and Bartlett's test of Spherity were computed to test the validity of the of the factor analysis of the data sets. The result of principle component analysis of egg trait extracted two factors that can objectively be used to describe the interrupted in the original elven egg quality characteristics of duck and geese. Therefore, the use of two orthogonal egg quality factor (PC1 and PC2) extracts from principle component analysis could be more reliable inter predicting egg quality compared to the use of the original inter correlated egg quality. The two principle factor could use in a breeding program for the important of egg quality traits.

Keywords: Waterfowl, Egg, Internal, External, and PCA

INTRODUCTION

Waterfowl such as duck and geese play a vital role in sustainable livelihood of resource poor farmers. There eggs are known as one of most important component of human diet because consumable as a protein and amino acids supplement (Polat, *et al.*, 2013). Moreover, the quality traits of eggs determine prices directly in commercial flocks and in egg processing enterprises, the weight of shell, albumen and yolk that from the egg as well as their compositions affect the amount and price of product (Farooq, *et al.*, 2003). The egg traits such as egg weight, egg width, albumen and yolk are very important in poultry production due to their influence on egg quality and grading (Farooq, *et al.*, 2001), particularly waterfowl have large yolk (about 35% egg weight) compared to the eggs of birds with antiracial development (about 20% egg weight). Principal component analysis is a mathematical procedure that transforms a number of possibly correlated variables into smaller number of uncorrelated variable. Principal component analysis has been used to describe the relationship between egg components (Shaker & Aziz, 2017; Abdullah & Shaker, 2018), carcass traits (Hermiz, *et al.*, 2018), and predictiopn of egg shape index components (Shaker, *et al.*, 2019).

The aim of the study was to evaluate the quality traits of external and internal variables of two waterfowl species, which located in Sulaimani city, Kurdistan, Iraq using principal component analysis. Moreover, study the correlation among egg characteristics, in order to deduce a model for predicting the internal characteristics of eggs using the external characteristics. This will help poultry farmers to identify eggs that will be useful in reproduction for quality and eggs that should be sold off or eaten as food.

MATERIALS AND METHODS

The present study was carried out in animal science department laboratories of Sulaimani University. From June 2017 to February 2018, a total of (160) eggs were collecting from local farms in Sulaimani province to evaluate some external (Egg weight "EW", Egg length "EL", Egg breadth "EB", Shell thickness "ShTh") in millimeter (mm), and internal (Yolk weight "YW", Albumin weight "AW", Shell weight "ShW", and Yolk diameter "YD") in Gram (g). And also Shape index "SI", and HU for both Yolk "YHU" and Albumin "AHU" for both species. All eggs weighed individually by using electronic balance with 0.01 g sensitivity, and Egg length and breadth of each egg was measured by using digital Vernier caliper with accuracy of 0.01 mm. after breaking the eggs, yolk separated from albumin and weighted, egg shell of the breaking eggs were washed with water and dried at room temperature for 24 hours. Following this

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procedure eggshell weight (ShW) with membranes was measured. Finally, albumin was wished by excluded yolk and shell weight from the total egg weight. Yolk diameter was estimated using the following equation (Yolk diameter (mm) = length * breadth / 2). Eggshells of broking eggs were washed with water and dried at room.

Mean, standard error, minimum and maximum of the external and internal traits for both species were calculated using the descriptive analysis of SPSS/PASW for windows version 19. Person's coefficients of correlation (r) among egg weight, external and internal egg traits were estimated. From the correlation matrix, data were generated for the principal component analysis. Anti-image correlation, Kaiser-Meyer-Olkin measures of sampling adequacy rotation component matrix, and Bartlett's test of Spherity were computed to test the validity of the of the factor analysis of the data sets (Jolloffe, 2002).

RESULTS AND DISCUSSION

Results:

Means, standard error, Maximum and minimum values for Egg weight, external and internal traits for both duck and geese are shown in table 1.

Table 1. Descriptive statistics of egg quality characteristics of duck and geese

Traits (Unit)	Duck; N=91			Geese; N=98		
	Mean ±S.E.	Minimum	Maximum	Mean ±S.E.	Minimum	Maximum
EW (g)	54.75 ±0.53	43.62	64.70	132.76 ±2.49	93.30	186.50
YW (g)	21.16 ±0.32	13.10	30.50	49.28 ±1.19	30.90	79.20
AW (g)	27.97 ±0.55	16.11	39.00	66.61 ±1.36	39.00	107.50
ShW (g)	5.61 ±0.08	3.45	8.21	16.87 ±0.33	11.60	24.10
EL (mm)	57.86 ±0.29	51.46	64.90	80.55 ±0.50	68.29	92.20
EB (mm)	41.90 ±0.14	39.03	44.43	54.38 ±0.37	47.33	61.72
ShTh (mm)	0.45 ±0.01	0.27	0.76	0.66 ±0.01	0.42	0.83
YD (mm)	41.77 ±0.37	33.03	50.00	56.80 ±0.66	19.19	71.22

EW=Egg weight; YW=Yolk weight; AW= Albumin weight; ShW= Shell weight; EL= Egg length; EB= Egg breadth; ShTh= Shell thickness; YD= Yolk diameter

Egg weight (EW) means were (54.75, 132.76) g for duck and geese respectively, which ranged between (43.62-64.70) g in duck and (93.30 - 186.50) g in geese. Yolk weight (YW) means were (21.16, 49.28) g for duck and geese respectively, which ranged between (13.10 - 30.50) g in duck and (30.90 - 79.20) g in geese. Albumin weight (AW) means were (27.97, 66.61) g for duck and geese respectively, which ranged between (16.11 - 39.00) g in duck and (39.00 - 107.50) g in geese. Shell weight (ShW) means were (5.61, 16.87) g for duck and geese respectively, which ranged between (3.45 - 8.21) g in duck and (11.60 - 24.10) g in geese. Egg length (EL) means were (57.86, 80.55) mm for duck and geese respectively, which ranged between (51.46 - 64.90) mm in duck and (68.29 - 92.20) mm in geese. Egg breadth (EB) means were (41.90, 54.38) mm for duck and geese respectively, which ranged between (39.03 - 44.43) mm in duck and (47.33 - 61.72) mm in geese. Shell thickness (ShTh) means were (0.45, 0.76) mm for duck and geese respectively, which ranged between (0.27 - 0.76) mm in duck and (0.42 - 0.83) mm in geese. Yolk diameter (YD) means were (41.77, 56.80) mm for duck and geese respectively, which ranged between (33.03 -50.00) mm in duck and (19.19 - 71.22) mm in geese.

Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was moderate for duck and geese in their external (0.648, 0.625) and internal traits (0.568, 0.597) respectively. Moreover the overall significance of correlation matrices tested by Barttelt test sphericity in both species for external traits was (chi-square = 60.918, P<0.001) and (chi-square = 111.11, P<0.001) respectively. And in internal traits the values were (chi-square = 30.872, P<0.001) and (chi-square = 166.45, P<0.001).

External egg components, Egin Values, percentage of total variance and communalities of both species are shown in table 2. The communalities of external egg traits in the two species was ranged (0.425-0.931), and (0.685-0.972) in Duck and Geese respectively. The values of communality computed for the two species confirm that PCA was appropriate for the data set. Two principal components were extracted from Duck with Egin values of 2.039 (PC1), 0.821 (PC2) and together accounted or 71.50% of total variance. In Geese the two principal components were extracted with Egin values of 2.237 (PC1) 0.971 (PC2) and together accounted for 80.19% of total variance.

Table 2. **Egin value, percentage of total variance, external component of Duck and Geese eggs**

Traits	Duck; N=91			Geese; N=98		
	PC1	PC2	Communalities	PC1	PC2	Communalities
EL	0.820	0.134	0.691	0.801	-0.292	0.726
EB	0.762	0.483	0.814	0.904	0.090	0.825
ShTh	-0.602	0.754	0.931	0.419	0.892	0.972
YD	0.651	-0.038	0.425	-0.777	-0.285	0.685
Egin value	2.039	0.821		2.237	0.971	
% of variance	50.976	20.528		55.914	24.276	

PC= Principal component; EW=Egg weight; YW=Yolk weight; AW= Albumin weight; ShW= Shell weight.

In the Duck, the first principal component (PC1) was characterized by high positive loadings on egg length (0.820) egg breadth (0.726) and moderate loading on yolk diameter (0.651) while shall-thickness showed moderate negative loading (-0.602). The second principal component (PC2) was characterized by high positive loadings on shell thickness (0.754) egg breadth (0.483) and moderate loadings on egg length (0.134) while yolk diameter showed low negative loading (-0.038). In the geese the first principal component (PC1) was characterized by high positive loadings on egg breadth (0.904) egg length (0.801) and moderate loadings on egg shell thickness (0.419) and yolk diameter showed high negative loading (-0.777). The second principal component (PC2) was characterized by high positive loadings on eggshell thickness (0.892), low loadings on egg breadth (0.090), and showed low negative loading on yolk diameter and egg length (-0.285) and (-0.292) respectively.

Internal egg components, Egin Values, percentage of total variance and communalities of both species are shown in table 3.

Table 3. **Egin value, percentage of total variance, internal component of Duck and Geese eggs**

Traits	Duck; N=91			Geese; N=98		
	PC1	PC2	Communalities	PC1	PC2	Communalities
YW	-0.713	0.599	0.867	0.848	0.502	0.972
AW	0.838	-0.036	0.704	0.849	-0.500	0.971
ShW	0.671	0.682	0.915	0.959	-0.001	0.910
Egin value	1.661	0.825		2.351	0.502	
% of variance	55.359	27.500		78.355	16.731	

PC= Principal component; EL= Egg length; EB= Egg breadth; ShTh= Shell thickness; YD= Yolk diameter.

The communalities represent estimates of variance in each variable accounted rang (0.704-0.915, 0.910-0.972 in Duck and Geese respectively). Two Principle components were extracted from Duck with Egin values of 1.661 (PC1), 0.825 (PC2) and together accounted for 82.86% of total variance. In the Geese the tow principle components were extracted with Egin values of 2.351 (PC1), 0.502 (PC2) and together accounted for 95.09% of total variance.

In the Duck: the first factor (PC1) was characterized by high positive loadings on albumin weight (0.838) and moderate loadings on shell weight (0.671) while yolk weight showed negative loading (-0.713). The second factor (PC2) was characterized by high positive loadings on shell weight (0.682) and moderate loadings on yolk weight (0.599) while albumin showed negative loading (-0.036). In the Geese first factor (PC1) was characterized by high positive loadings on all three components (shell, albumin, yolk) weight (0.959, 0.849, 0.848 respectively). The second factor (PC2) was characterized by moderate loadings on yolk weight (0.502) while shell weight and albumin weight showed negative loading (-0.01 and -0.500 respectively). Table 3 describes internal components of Duck and Geese eggs.

Pearson's coefficients of correlation between egg traits for duck and geese are given in table 4. The correlation coefficients ranged from (-0.421 – 0.918), (0.101 – 0.965) in duck, and geese respectively. The relationships between egg traits were almost positive.

Table 4.

	Traits	EW	YW	AW	ShW	EL	EB	ShTh	YD
Duck	EW	1							
	YW	0.142$^{N.S.}$	1						
	AW	0.829***	-0.421***	1					
	ShW	0.435***	-0.176$^{N.S.}$	0.379***	1				
	EL	0.759***	0.225*	0.587***	0.157$^{N.S.}$	1			
	EB	0.918***	0.088$^{N.S.}$	0.786***	0.400***	0.554***	1		
	ShTh	-0.237*	-0.024$^{N.S.}$	-0.246*	0.191$^{N.S.}$	-0.371***	-0.196$^{N.S.}$	1	
	YD	0.315**	0.286**	0.160$^{N.S.}$	-0.134$^{N.S.}$	0.317**	0.337**	-0.264*	1
Geese	EW	1							
	YW	0.846***	1						
	AW	0.881***	0.498***	1					
	ShW	0.905***	0.758***	0.760***	1				
	EL	0.780***	0.622***	0.744***	0.605***	1			
	EB	0.965***	0.853***	0.813***	0.888***	0.629***	1		
	ShTh	0.360***	0.271**	0.292**	0.554***	0.101$^{N.S.}$	0.388***	1	
	YD	0.571***	0.606***	0.408***	0.469***	0.488***	0.580***	0.110$^{N.S.}$	1

EW=Egg weight; YW=Yolk weight; AW= Albumin weight; ShW= Shell weight; EL= Egg length; EB= Egg breadth; ShTh= Shell thickness; YD= Yolk diameter.

Discussion:

Eggs traits regarding external and internal components have studied by many investigators (Amao & Olugbemiga, 2016). These work was done to evaluate (Adamski, *et al*., 2005), characterize (Yakubu, 2013), and to predicted relationships among the traits (Mazanowski, *et al*., 2005). Saatci, *et al*. (2005) found that egg traits variation in waterfowl affected by birds color. This result clarifies the reason of wide value variation in egg weight and its traits. Our results disagreeing with Kokoszynski, *et al*. (2007) who recorded traits values higher then our finding. Our extremism values also come back from the laying time (Okruszek, *et al*., 2006). Moreover our result it agreed with (Hepp, *et al*., 1987).

CONCLUSION

The result of principle component analysis of egg trait extracted two factors that can objectively be used to describe the interrupted in the original elven egg quality characteristics of duck and geese. Therefore the use of two orthogonal egg quality factor (PC1 and PC2) extracts from principle component analysis could be more reliable inter predicting egg quality compared to the use of the original inter correlated egg quality .The two principle factor could use in a breeding program for the important of egg quality traits.

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إستخدام تحليل المكون الرئيسي لتوصيف مكونات البيضة في نوعين من الطيور المائية

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اجريت الدراسة الحالية في مختبرات قسم علوم الحيوان التابعة لجامعة السليمانية في العراق. خلال الفترة من حزيران ٢٠١٧ الى شباط ٢٠١٨ جمعت (٩١) بيضة بط و (٩٨) بيض الاوز من المزارع المحلية لتقييم بعض الصفات الخارجية و الداخلية. تم وزن البيض بشكل فردي باستخدام ميزان الكتروني بحساسية ٠.٠١ غم، و تم قياس طول البيضة و اتساعها بأستخدام الورنية الرقمية بدقة ٠.٠١ ملم. بعد كسر البيض، تم قياس وزن كل من صفار البيض، زلال البيض، و وزن القشرة. علاوة على ذلك، تم تقدير قطر صفار البيض. المعدل، الخطئ القياسي و القيمة الدنيا و العليا للصفات الداخلية و الخارجية للبيض في كلا النوعين قد تم تقدبرهما بواسطة التحليل الوصفي لبرنامج التحليل الاحصائي SPSS . و كذلك معدل الارتباط تم تقديرة لصفات البيض الخارجية و الداخلية. من مصفوفة الارتباط تم انشاء البيانات لتحليل المكون الرئيسي، وكدلك تم حساب الارتباط المضاد و مقياس Bartlett للمصفوفة. و اختبار Kaiser-Meyer-Olkin تم إجراءه لاختيار صحة تحليل لمجموعة البيانات. تم استخلاص عاملية نتيجة التحليل الاساسي لمكونات البيضة و يمكن استخدامهما بموضوعية لوصف خصائص البيضة الخارجية و الداخلية للبط و الاوز