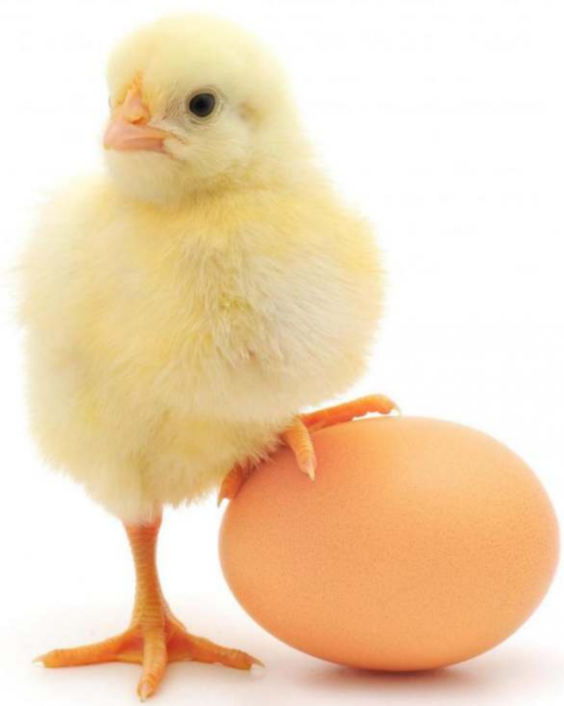
ISSN 1682-8356
ansinet.org/ijps



INTERNATIONAL JOURNAL OF POULTRY SCIENCE

ANSInet
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan
Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorijps@gmail.com

OPEN ACCESS International Journal of Poultry Science

ISSN 1682-8356
DOI: 10.3923/ijps.2019.76.79

Research Article
Using Principal Component Analysis to Identify Components Predictive of Shape Index in Chicken, Quail and Guinea Fowl

[1]Ahmed S. Shaker, [2]Questan A. Amin, [2]Shilan A. Akram, [2]Shahla M.S. Kirkuki, [2]Rozhgar S. Bayez Talabani, [3]Nidhal A. Mustafa and [1]Mohammed Sardar Mohammed

[1]Department of Animal Production, Agriculture Research Center, Sulaimani, Iraq
[2]Department of Animal Sciences, College of Agricultural sciences, Sulaimani University, Sulaimani, Iraq
[3]Department of Animal Production, College of Agriculture, Salahaddin University, Erbil, Iraq

Abstract
Background and Objective: The shape index of avian eggs is used as an indicator for predicting chick weight, hatchability and eggshell quality. However, the components that most contribute to shape index remain unknown. The aim of this study was to provide an objective description of shape index using principal component analysis and to predict shape index from egg measurements derived from this analysis. **Materials and Methods:** The present study was carried out in the Animal Production Department laboratories of Sulaimani University, Sulaimani, Iraq. From July 2017 to February 2018, a total of 98, 95 and 56 chicken, quail and guinea fowl eggs respectively were collected from local markets. Digital balance and vernier calipers were used to measure the traits. Then descriptive analysis, correlations and principal component analysis were determined by using SPSS program. **Results:** The guinea fowl and quail had high egg shape indexes of 79.24 and 79.00% respectively, followed by the chicken (75.19%). The relationships between the shape index and the majority of the egg components were positive and significant ($p<0.05$) in all three species. Bartlett's test of sphericity on the egg components for the chicken ($\chi^2 = 150.354$, $p = 0.000$), quail ($\chi^2 = 133.322$, $p = 0.000$) and guinea fowl ($\chi^2 = 256.323$, $p = 0.000$) were also highly significant. Two principal components were extracted for each species with eigenvalues that, when combined, accounted for 82.5, 84.1 and 94% of the total variance for the chicken, quail and guinea fowl respectively. **Conclusion:** Easily measured, descriptive features can be used to predict the shape index of the eggs of gallinaceous birds, which helps toward selecting eggs and improving production.

Key words: Chicken, genuine fowl, principal component analysis, quail, Shape index

Received: May 13, 2018 Accepted: November 20, 2018 Published: January 15, 2019

Citation: Ahmed S. Shaker, Questan A. Amin, Shilan A. Akram, Shahla M.S. Kirkuki, Rozhgar S. Bayez Talabani, Nidhal A. Mustafa and Mohammed Sardar Mohammed, 2019. Using principal component analysis to identify components predictive of shape index in chicken, quail and guinea fowl. Int. J. Poult. Sci., 18: 76-79.

Corresponding Author: Ahmed S. Shaker, Department of Animal Production, Agriculture Research Center, Sulaimani, Iraq

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

The importance of the shape index of avian eggs as an indicator for predicting chick weight[1], hatchability[2] and eggshell quality[3,4] has been well established in the literature. Furthermore, there have been many attempts to identify the components that affect egg shape index mathematically[5-8], including genetic[9,10] and environmental[11] factors.

Principal component analysis (PCA) is one of the multivariate procedures used to analyze and assess variations among traits. PCA was first introduced by Karl Pearson[12] and then by Hotelling[13]. It has been frequently used to predict the relevant components of many traits in chickens that are associated with egg production[14-18] and carcass[19-21] and morphological features[22].

Therefore, this study was undertaken to provide an objective description of the shape index using PCA and to predict shape index using egg measurements derived from this analysis.

MATERIALS AND METHODS

The present study was carried out in the Animal Production Department laboratories of Sulaimani University. From July 2017 to February 2018, fresh eggs with unbroken shells were collected from three different local markets in the Sulaimani province. A total of 98, 95, 56 eggs were collected from chicken, quail and guinea fowl respectively.

Each egg was weighed using a digital balance to the nearest of 0.01 g. Both egg length and breadth were measured using digital vernier calipers and shape index was calculated using the following equation:

$$\text{Shape index} = \frac{\text{Breadth}}{\text{Length}} \times 100$$

After breaking the eggs, yolk length and width were measured using digital vernier calipers and yolk diameter was estimated using the following equation:

$$\text{Yolk diameter} = \frac{\text{Length} \times \text{breadth}}{2}$$

Mean, standard error and coefficients of variation for egg weight, length, breadth, shape index and yolk diameter of the three species were determined using SPSS version 19.0 (Company Name, City, State, USA). Pearson correlation coefficients between the shape index and egg measurements were calculated. The suitability of data for PCA was established using Bartlett's test of sphericity, followed by the Kaiser-Meyer-Olkin (KMO) test and anti-image correlations to measure the sampling adequacy.

RESULTS

The mean, standard error and coefficients of variation for shape index and egg components for the three species are presented in Table 1. Guinea fowl and quail had high egg shape indexes (79.24, 79.00% respectively) followed by chicken (75.19%).

The coefficients of correlation between shape index and egg components for the three species are presented in Table 2. The coefficient of correlations were ranged -0.082 -0.782, -0.037 -0.701 and -0.657 -0.961 in chicken, quail and guinea fowl respectively. The relationship between the shape index and the egg components were positive and significant ($p<0.05$) in the three species of gallinaceous birds. Highly significant ($p<0.001$) positive correlations were observed for egg breadth and egg shape index (0.782), egg length and egg weight (0.771), egg breadth and egg weight (0.660) and egg breadth and egg length (0.504) in chickens; in quails, egg length and egg weight (0.701), egg breadth and end egg length (0.652) and egg breadth and egg weight (0.647) and finally, in guinea fowl, egg breadth and egg weight (0.961), egg length and egg weight (0.792), yolk diameter and egg weight (0.789), yolk diameter and egg length (0.775), yolk diameter and egg breadth (0.787) and egg breadth and egg length (0.719). The KMO values determined for chicken, quail and guinea fowl were 0.680, 0.706 and 0.723, respectively.

Table 1: Shape index and egg components

	Chicken (n = 98)		Quail (n = 95)		Guinea fowl (n = 56)	
Traits	Mean	CV	Mean	CV	Mean	CV
Egg shape index (%)	75.19±0.46[a]	6.00	79.00±0.30[b]	3.67	79.24±0.57[b]	5.35
Egg weight (g)	50.70±0.61	11.98	10.99±0.13	11.58	35.84±0.63	13.15
Egg length (mm)	54.86±0.25	4.43	32.51±0.16	4.78	47.83±0.42	6.64
Egg breadth (mm)	41.24±0.30	7.17	25.65±0.10	3.86	37.82±0.27	5.25
Yolk diameter (mm)	37.91±0.21	5.45	25.51±0.49	18.62	40.37±0.78	14.38

CV: Coefficient of variation

Table 2: Coefficients of correlation between shape index and egg components

Birds	Traits	Egg shape index (%)	Egg weight (g)	Egg length (mm)	Egg breadth (mm)	Yolk diameter (mm)
Chicken	Egg shape index (%)	1				
	Egg weight (g)	0.215*	1			
	Egg length (mm)	-0.142^{NS}	0.771***	1		
	Egg breadth (mm)	0.782***	0.660***	0.504***	1	
	Yolk diameter (mm)	-0.082^{NS}	-0.324**	-0.244*	-0.233*	1
Quail	Egg shape index (%)	1				
	Egg weight (g)	-0.220*	1			
	Egg length (mm)	-0.605***	0.701***	1		
	Egg breadth (mm)	0.208*	0.647***	0.652***	1	
	Yolk diameter (mm)	-0.019^{NS}	-0.037^{NS}	-0.171^{NS}	-0.230*	1
Guinea fowl	Egg shape index (%)	1				
	Egg weight (g)	-0.088^{NS}	1			
	Egg length (mm)	-0.657***	0.792***	1		
	Egg breadth (mm)	0.040^{NS}	0.961***	0.719***	1	
	Yolk diameter (mm)	-0.233^{NS}	0.789***	0.775***	0.787***	1

***Correlation is significant at the 0.001 level, **Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level, ^{NS}correlation is not significant

Table 3: Eigenvalues, total variance and communalities for shape index and egg components

	Chicken			Quail			Guinea fowl		
Traits	PC1	PC2	Communalities	PC1	PC2	Communalities	PC1	PC2	Communalities
Egg weight (g)	0.925	0.123	0.871	0.868	0.263	0.822	0.961	-0.220	0.972
Egg length (mm)	0.852	0.191	0.762	0.887	0.076	0.793	0.886	0.384	0.854
Egg breadth (mm)	0.797	0.181	0.667	0.873	-0.034	0.763	0.941	-0.317	0.933
Yolk diameter (mm)	-0.479	0.877	0.999	-0.278	0.953	0.986	0.905	0.187	0.986
Eigenvalue	2.446	0.854		2.380	0.985		3.414	0.331	
Variance (%)	61.148	21.338		59.488	24.615		85.346	8.279	

PC1: Principal Component 1, PC2: Principal component 2

The results of Bartlett's test of sphericity for the egg components of the chicken (χ^2 = 150.354, p = 0.000), quail (χ^2 = 133.322, p = 0.000) and guinea fowl (χ^2 = 256.323, p = 0.000) were also highly significant.

Eigenvalues, percentages of the total variance and the commonalities of the shape index for the shape index and egg components of the three species of gallinaceous birds are present in Table 3. The communalities ranged 0.667-0.999, 0.763-0.986 and 0.854-0.986 in chicken, quail and guinea fowl respectively. Two principal components were extracted from chickens with eigenvalues of 2.446 for the first principal component (PC1) and 0.854 for the second (PC2); these two principal components accounted for 82.5% of the total variance. In quail, two principal components were extracted with eigenvalues of 2.380 for the first (PC1) and 0.985 for the second (PC2); these two principal components accounted for 84.1% of the total variance. For guinea fowl, the eigenvalues of PC1 and PC2 were 3.414 and 0.331, respectively and these accounted for 94% of the total variance.

DISCUSSION

In the current study, PCA was applied to obtain data on three species of gallinaceous birds (chicken, quail and guinea fowl) to determine the most explanatory variables of the total variance and shape index. Similar results were found by Song *et al.*[23] using four species (pheasant, chukar, quail and guinea fowl) and also by Sogunle *et al.*[24] using three species (chicken, duck and guinea fowl), that no species differences were observed in the ration and compositions of albumen and yolk. Among the species, the lowest coefficients of variation for shape index were 3.67, 5.35 and 6.00% in quail, guinea fowl and chicken respectively. Also, egg breadth was reduced by 3.86, 5.25 and 7.17 mm in quail, guinea fowl and chicken respectively. Both of these results indicate that these traits are affected by genetic factors[25]. In terms of egg traits, egg weight in both chicken and guinea fowl and egg length in quail were found to be the most effective parameters in PC1. Yolk diameter in both chicken and quail and egg length in guinea fowl were found to have the most loading in PC2. The positive relationship between the shape index and the majority of egg traits in all three species showed that the former could be predicted from the latter. These results support the findings of Duman *et al.*[26] who used chickens to study the relationship between the shape index and egg characteristics and found that the shape index was significantly affected by egg weight, length and breadth.

CONCLUSION

Based on the results of the current study it can be concluded that two PC were extracted from each of the three species, which could be used to predict the shape index of their eggs. And also help for selection and improving the production.

ACKNOWLEDGMENTS

The authors acknowledge the financial assistance provided by the Agricultural Research Center and Kosar Company.

REFERENCES

1. Narushin, V.G., M.N. Romanov and V.P. Bogatry, 2002. AP-Animal production technology: Relationship between pre-incubation egg parameters and chick weight after hatching in layer breeds. Biosyst. Eng., 83: 373-381.
2. Asci, E. and I. Durmus, 2015. Effect of egg shape index on hatching characteristics in hens. Turk. J. Agric. Food Sci. Technol., 3: 583-587.
3. Nikolova, N. and D. Kocevski, 2006. Forming egg shape index as influenced by ambient temperatures and age of hens. Biotechnol. Anim. Husband., 22: 119-125.
4. Altuntas, E. and A. Sekeroglu, 2008. Effect of egg shape index on mechanical properties of chicken eggs. J. Food Eng., 85: 606-612.
5. Barta, Z. and T. Szekely, 1997. The optimal shape of avian eggs. Funct. Ecol., 11: 656-662.
6. Bridge, E.S., R.K. Boughton, R.A. Aldredge, T.J. Harrison, R. Bowman and S.J. Schoech, 2007. Measuring egg size using digital photography: Testing hoyt's method using florida scrub jay eggs. J. Feild Ornithol., 78: 109-116.
7. Havlicek, M., S. Nedomova, J. Simeonovova, L. Severa and I. Krivanek, 2008. On the evaluation of chicken egg shape variability. Acta Univ. Agric. Silvic. Mendel. Brun., 56: 69-74.
8. Nishiyama, Y., 2012. The mathematics of egg shape. Int. J. Pure Appl. Math., 78: 679-689.
9. Minvielle, F., B.B. Kayang, M. Inoue-Murayama, M. Miwa and A. Vignal *et al*., 2006. Search for QTL affecting the shape of the egg laying curve of the Japanese quail. BMC Genet., Vol. 7. 10.1186/1471-2156-7-26
10. Shaker, A.S., S.M.S. Kirkuki, S.R. Aziz and B.J. Jalal, 2017. Influence of genotype and hen age on the egg shape index. Int. J. Biochem. Biophy. Mol. Biol., 2: 68-70.
11. Mao, K.M., A. Murakami, A. Iwasawa and N. Yoshizaki, 2007. The asymmetry of avian egg-shape: An adaptation for reproduction on dry land. J. Anat., 210: 741-748.
12. Karl Pearson, F.R.S., 1901. LIII. On lines and planes of closest fit to systems of points in space. Lond. Edinburgh Dublin Phil. Maga. J. Sci., 2: 559-572.
13. Hotteling, H., 1935. The most predictable criterion. J. Educ. Psychol., 26: 139-142.
14. Savegnago, R.P., S.L. Caetano, S.B. Ramos, G.B. Nascimento, G.S. Schmidt, M.C. Ledur and D.P. Munari, 2011. Estimates of genetic parameters and cluster and principal components analyses of breeding values related to egg production traits in a White Leghorn population. Poult. Sci., 90: 2174-2188.
15. Sarica, M., H. Onder and U.S. Yamak, 2012. Determining the most effective variables for egg quality traits of five hen genotypes. Int. J. Agric. Boil., 14: 235-240.
16. Venturini, G.C., R.P. Savegnago, B.N. Nunes, M.C. Ledur, G.S. Schmidt, L.E. Faro and D.P. Munari, 2013. Genetic parameters and principal component analysis for egg production from White Leghorn hens. Poult. Sci., 92: 2283-2289.
17. Shaker, A.S. and S.R. Aziz, 2017. Internal traits of eggs and their relationship to shank feathering in chicken using principal component analysis. Poult. Sci. J., 5: 1-5.
18. Ukwu, H.O., P.O. Abari and D.J. Kuusu, 2017. Principal component analysis of egg quality characteristics of ISA Brown layer chickens in Nigeria. World Sci. News, 70: 304-311.
19. Pinto, L.F.B., I.U. Packer, C.M.R. de Melo, M.C. Ledur and L.L. Coutinho, 2006. Principal components analysis applied to performance and carcass traits in the chicken. Anim. Res., 55: 419-425.
20. Ogah, D.M., 2011. Assessing size and conformation of the body of Nigerian Indigenous Turkey. Slovak J. Anim. Sci., 44: 21-27.
21. Udeh, I. and C.C. Ogbu, 2011. Principal component analysis of body measurements in three strains of Broiler chicken. Sci. World J., 6: 11-14.
22. Yakubu, A., D. Kuje and M. Okpeku, 2009. Principal components as measures of size and shape in Nigerian indigenous chickens. Thai J. Agric. Sci., 42: 167-176.
23. Song, K.T., S.H. Choi and H.R. Oh, 2000. A comparison of egg quality of pheasant, chukar, quail and guinea fowl. Asian-Aust. J. Anim. Sci., 13: 986-990.
24. Sogunle, O.M., A.A. Ayoade, A.O. Fafiolu, K.O. Bello, D.A. Ekunseitan, K.K. Safiyu and O.J. Odutayo, 2017. Evaluation of external and internal traits of eggs from three poultry species at different storage durations in tropical environment. Niger. J. Anim. Sci., 2: 177-189.
25. Baker, C.M.A., 1960. The genetic basis of egg quality. Br. Poult. Sci., 1: 3-16.
26. Duman, M., A.Sekeroglu, A. Yildirim, H. Eleroglu and O. Camci, 2016. Relation between egg shape index and egg quality characteristics. Eur. Poult. Sci., Vol. 80. 10.1399/eps.2016.117.