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Research Article

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Comparative Evaluation of Egg Quality Traits in Two Exotic Chicken Breeds

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Abstract

The challenge of meeting the nutritional needs of growing populations in developing countries, like in Ethiopia, underscores the importance of optimizing protein and calorie sources. Traditional animal husbandry in Ethiopia, characterized by low inputs and productivity, contributes to a deficiency in animal protein supply. Eggs, as a cost-effective and nutrient-rich protein source, hold significant potential for addressing this issue. This study was conducted with the aims to compare and contrast the egg quality traits of two exotic chicken breeds, fayoumi and koekoek, under intensive management conditions. The focus is on understanding the structural and functional aspects of eggs produced by these breeds, contributing valuable insights to the poultry sector. Egg quality traits, including albumen height, weight, egg dimensions, shell characteristics, yolk properties, and Haugh unit (HU), were measured and statistical analyses were performed using SAS software. The results obtained revealed significant breed differences in egg quality attributes between the two breeds. Fayoumi exhibited specific characteristics such as albumen height and weight, egg length, and shell weight, while koekoek excelled in albumen weight, egg length, and yolk properties. The findings support the sustainable utilization of exotic chicken breeds for enhanced chicken production to meet consumer demands. Understanding the distinct egg quality attributes of these breeds contributes valuable knowledge for breed selection, developing synthetic breeds through crossing and management practices.

Keywords

Breed effect, Egg quality traits, Exotic chicken breeds

Introduction

The inability of most developing countries to effectively feed their rapidly expanding populations with the right balance of calories and protein ranks among their biggest developmental concerns [1]. Ethiopia's dependence on the traditional animal husbandry system, which is marked by low inputs, high feed costs, and low productivity of indigenous livestock breeds, results in an inadequate supply of animal protein. Eggs are reasonably priced and a good source of balanced, high-quality nutrients [2]. The majority of people around the world consume and enjoy eggs, which are the only balanced food of animal origin consumed in large quantities (apart from cow milk) [3]. Poultry is one of the animal sectors that is now expanding quickly on a global scale [4]. In addition, chickens are socially and culturally accepted everywhere and are not prohibited by traditional customs or religions. Understanding the structure of the egg and its many properties is crucial for knowledge about egg quality, fertility, embryo development, chick production, and poultry diseases [5]. Internal and external quality traits serve as the foundation for egg quality standards. Hens that produce poor-quality eggs should be culled, and proper hen care can aid in raising egg quality [6]. These quality attributes are controlled by both genetics and en-

vironmental factors. The more significant pricing determining element for hatching and table eggs is egg quality. Therefore, a laying flock's economic performance only rests on the overall volume of high-quality eggs produced [7, 8]. The most crucial exterior features for marketing, egg preservation, and customer acceptability are cleanliness of the shell, soundness of the eggshell, shape, egg weight, shell weight, and freshness [9, 10]. For the egg-producing sector, internal egg quality traits such as relative viscosity, foaming, gelling, yolk index, Haugh index, chemical composition, hardness, and lack of foreign materials in albumen are crucial [10]. Chicken population in Ethiopia is estimated to be 56.1 million of which 49.4, 3.6 and 3.0 million are indigenous, hybrid and exotic birds, respectively. Although a great deal of research has been done on local Ethiopian chicken breeds on egg quality characteristics, there is little available information on exotic chicken breeds that have been imported and are currently becoming popular. Therefore, the primary goal of this study was to compare and contrast the egg quality traits of two distinct exotic chicken breeds namely the fayoumi and koekoek raised under intensive management. The findings support the sustainable use of exotic chicken genetic resources and the increase of chicken production to meet consumer demand for chicken products.

Materials and Methods

Study area location

The study was conducted at Haramaya University poultry farm located at 42° 3' E longitude, 4° 26' N latitude and at an altitude of 1980 meters above sea level. The average annual rainfall of the area is 780 mm, and the average minimum and maximum temperatures are 8.25 °C and 23.4 °C, respectively.

Birds' management

Two exotic chicken breeds, i.e., fayoumi and koekoek, were raised under an intensive management system. The chickens were maintained in brooder houses with incandescent heating lamps for the first eight weeks of their lives. Then, they were raised in the grower house during the growing season and in the layer house of the deep litter system during the laying season. Ad libitum water and the recommended amount of food, a standard ration of 20% CP and 2800 kcal/kg ME during the first eight weeks, 16% CP and 2800 kcal/kg ME during the growing stage (9 to 20 weeks), and 16.50% CP and 1750 kcal/kg ME during the laying stage, were provided to the chickens in accordance with their needs. Birds were vaccinated against Marek's, Newcastle, Gumboro, Fowl pox and Typhoid. In addition, veterinary treatments were applied throughout the study when necessary.

Traits measured

For this investigation, a total of 1443 eggs (750 from the fayoumi breed and 693 from the koekoek breed) were used. Ten traits of egg quality i.e., albumen height (AH), albumen weight (AW), egg length (EL), egg width (EWi), egg weight (EW), shell weight (SW), yolk color (YC), yolk height (YH), and yolk weight (YW) were recorded. Albumen and AH and YH were measured in mm by a spherometer (Tripod stand). AW, EW, and YW were measured in gram on an electronic balance. SWs were recorded in gram with the help of an electronic balance after properly drying the eggshell. EL was measured by a digital calliper with an accuracy of 1 mm, while EWi was measured using Vernier callipers with the least count of 0.01 mm. The YC of the eggs was compared with the standard colors available in Roche's yolk color fan (15 colors ranging from light yellow to deep orange) and scoring was done accordingly. HU was determined via the formula below:

$$HU = 100 \log (H + 7.57 - 1.7 W^{0.37})$$

Where, H = Height of dense albumin in mm; and W = Weight of egg (g).

Statistical data analysis

Version 9.4 of the SAS program was used for all statistical analyses in this study [11].

Exploratory data analysis

Using SAS' PROC UNIVARIATE procedure, the traits of egg quality were submitted to exploratory data analysis to produce descriptive statistics [11].

Analysis of variance

The traits AH, AW, EL, EW, EWi, SW, YC, YH, YW, and HU were subjected to a one-way analysis of variance using the general linear model procedure (PROC GLM) of SAS. When the results were significant at alpha ≤ 0.05, the treatment means were separated using the student's t-test. The linear model employed was:

$$Y_{ij} = \mu + B_i + \varepsilon_{ij}$$

Where, Y_{ij} = Observed value of the egg quality trait (AH, AW, EL, EW, EWi, SW, YC, YH, YW, and HU); μ = Overall mean; B_i = Fixed effect of the i^{th} breed (i = Fayoumi and koekoek); and ε_{ij} = Error term.

Results and Discussion

Exploratory data analysis

Table 1 below presents the descriptive statistics for various egg quality traits of the two exotic chicken breeds, fayoumi and koekoek.

The findings indicate that for the fayoumi breed, the mean AH was 6.6 and the mean AW was 26.0. This outcome is consistent with the results of Tabinda et al. [12] and Markos et al. [13]. The average EW was 44.3 with a CV of 9.4 and the average EL was 5.0 with a CV of 6.0. The average AH for the koekoek breed was 6.4, with a CV of 19.2. Similar results were also obtained by Narushin and Romanov [14]. In disagreement with the mean EH of 5.3, with a CV of 5.8, and the mean EW of 50.4, with a CV of 7.9, the mean AW was 29.8, with a CV of 9.3 [15, 16]. The mean EWi and mean SW for the fayoumi breed were 3.8 and 4.0, respectively, with a CV of 6.1 and 19 as also reported by Samson et al. [17] and Radwan et al. [18]. For the koekoek breed, the mean EWi was 4.0, with a CV of 5.1, and the mean SW was 3.9, with a CV of 16.2, as was also reported by Muhammed et al. [19] and Setsumi and Mahlehla [20]. The mean YC was 1.4, with a CV of 39.3, and the mean

Table 1: Descriptive statistic results of egg quality traits for the two exotic chicken breeds.

S. No	Trait	Label	Fayoumi		Koekoek	
			Mean	CV	Mean	CV
1	Albumen height	AH	6.6	20.2	6.4	19.2
2	Albumen weight	AW	26.0	11.5	29.8	9.3
3	Egg length	EL	5.0	6.0	5.3	5.8
4	Egg weight	EW	44.3	9.4	50.4	7.9
5	Egg width	EWi	3.8	6.1	4.0	5.1
6	Shell weight	SW	4.0	19	3.9	16.2
7	Yolk color	YC	1.4	39.3	1.3	38.9
8	Yolk height	YH	14	7.9	14.6	7.3
9	Yolk weight	YW	14.3	11.5	16.2	10.7
10	Haugh unit	HU	85.8	9.5	82.4	9.6

Note: CV = Coefficient of variation.

yolk height was 14, with a CV of 7.9 for the fayoumi breed. The mean yolk height was 14.6, and the mean YC was 1.3, with a CV of 7.3 and 38.9, respectively, for the koekoek breed and the mean yolk weight was 16.2, with a CV of 10.7, while the mean HU was 82.4, with a CV of 9.6 [21, 22]. The mean YW for the fayoumi breed was 14.3, with a CV of 11.5, and the mean HU was 85.8, with a CV of 9.5.

Analysis of Variance: Least-square means (LSM) along with their standard error (SE) of the egg quality traits are presented in table 2. The analysis of variance revealed a very highly significant ($p < 0.0001$) effect of breed on all investigated.

The koekoek breed demonstrated a significantly lower mean AH (6.42 cm), contrasting with the fayoumi breed's higher mean (6.64 cm), aligning with previous studies by Dzungwe et al. [23] and Sreenivas et al. [24]. Koekoek exhibited a greater mean AW (29.83 g), akin to white leghorn and isa brown breeds [25], surpassing fayoumi's mean (26.04 g) as reported by Alemu [26]. The p-value (< 0.0001) underscores the breed's significant influence, with koekoek > fayoumi. The average EL for koekoek was 5.26 cm, in line with the literature [27, 28], while fayoumi's average was 5.05 cm. The breed effect ($p < 0.0001$) confirmed koekoek > fayoumi in this trait. Koekoek excelled in EW averaging 50.41 g, comparable to findings in [29, 30]. Fayoumi recorded a lower mean (44.31 g), with a significant breed effect ($p < 0.0001$) favoring koekoek [31]. EWi results indicated koekoek's superiority (3.97 cm) over fayoumi (3.76 cm), consistent with Thobela et al. [21] and Alemu [26]. The p-value (< 0.0001) confirmed koekoek > fayoumi for this trait. Fayoumi led in SW (3.99 g), although below [27], with koekoek following closely (3.89 g). The p-value (< 0.0001) emphasized the breed effect, favoring fayoumi > koekoek. Koekoek exhibited a higher mean YC (1.28) compared to fayoumi (1.37), aligning with Alemu [26]. The p-value (< 0.0001) indicated a significant breed effect, favoring fayoumi > koekoek. For YH, koekoek surpassed fayoumi (14.62 cm vs 14.00 cm), consistent with Alemu [26]. The p-value (< 0.0001) confirmed koekoek > fayoumi in this trait. Koekoek also outperformed in YW (16.22 g), surpassing fayoumi's mean (14.35 g). The breed effect was significant ($p < 0.0001$), favoring koekoek. In conclusion, this study highlights significant differences in egg quality traits between fayoumi and koekoek breeds, contributing valuable insights for poultry breeders and researchers.

Conclusion

This study aimed to compare and contrast the egg quality traits of two distinct exotic chicken breeds namely the fayoumi

Table 2: Pooled least square means (± SE) of egg quality traits of the exotic breeds.

Trait (unit)	Breed		
	Fayoumi	Koekoek	p-value
	LSM ± SE	LSM ± SE	
AH (cm)	6.64^{a} ± 0.05	6.42^{b} ± 0.05	< 0.0001
AW (g)	26.04^{b} ± 0.11	29.83^{a} ± 0.12	< 0.0001
EL (cm)	5.05^{b} ± 0.01	5.26^{a} ± 0.01	< 0.0001
EW (g)	44.31^{b} ± 0.16	50.41^{a} ± 0.17	< 0.0001
EWi (cm)	3.76^{b} ± 0.01	3.97^{a} ± 0.01	< 0.0001
SW (g)	3.99^{a} ± 0.03	3.89^{b} ± 0.03	< 0.0001
YC	1.37^{a} ± 0.02	1.28^{b} ± 0.02	< 0.0001
YH (cm)	14.00^{b} ± 0.04	14.62^{a} ± 0.04	< 0.0001
YW (g)	14.35^{a} ± 0.06	16.22^{b} ± 0.06	< 0.0001
HU	85.78^{a} ± 0.32	82.40^{b} ± 0.33	< 0.0001

Note: ^{a,b} when different superscripts are indicated in the same row for a given trait, it means that there is a significant ($p < 0.05$) effect of the breed. AH = albumen height; AW = albumen weight; EL = egg length; EW = egg weight; EWi = egg width; SW = shell weight; YC = yolk color; YH = yolk height; YW = yolk weight; and HU = Haugh unit.

and koekoek raised under intensive management conditions. A total of 1443 eggs, 750 from the fayoumi breed and 693 from the koekoek breed, were analysed for ten egg quality traits.

The results of the study revealed significant differences in egg quality traits between the fayoumi and koekoek breeds. The koekoek breed exhibited a significantly lower mean AH compared to the fayoumi breed. Additionally, koekoek had higher means for AW, EL, EW, and EWi compared to fayoumi. On the other hand, fayoumi had higher means for SW, YC, YH, and YW compared to koekoek. Crossing the two breeds can thus lead to the advantages of using the combining ability of the different traits. These findings have important implications for poultry breeders and researchers, with the results found highlighting the significant impact of chicken breed on egg quality traits, providing breeders with valuable information for selecting and crossing breeds for optimal egg production. By understanding and optimizing egg quality traits, poultry farmers can improve the economic performance of their laying flocks and effectively meet the nutritional needs of the populations. This research contributes to the broader goal of ensuring food security and addressing developmental concerns related to feeding the rapidly expanding populations.

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Conflict of Interest

The authors affirm that there are no conflicts of interest with this publication.

References

1. Apantaku SO. 2006. Analysis of participation of farmers in participatory poultry production research in Lagos State, Nigeria. *Livest Res Rural Dev* 18(7).
2. Réhault-Godbert S, Guyot N, Nys Y. 2019. The golden egg: nutritional value, bioactivities, and emerging benefits for human health. *Nutrients* 11(3): 684. https://doi.org/10.3390/nu11030684
3. Baishya D, Dutta KK, Mahanta JD, Borpujari RN. 2008. Studies on certain qualities of different sources of chicken eggs. *Tamil Nadu J Vet Anim Sci* 4: 139-141.
4. The Poultry Site. 2015. Global Poultry Trends: Strong Growth in Egg Output Recorded in Africa and Oceania. [https://www.thepoultrysite.com/articles/global-poultry-trends-strong-growth-in-egg-output-recorded-in-africa-and-oceania] [Accessed on February 15, 2024]
5. Islam MS, Dutta RK. 2010. Egg quality traits of indigenous, exotic, and crossbred chickens (*Gallus domesticus* L.) in Rajshahi, Bangladesh. *J Life Earth Sci* 5: 63-67.
6. Walelegne A, Aberra M, Kefyalew B. 2021. Comparative study on egg quality traits of indigenous chickens and their F1-crosses with the sasso chicken breed in Sheka zone, Southwestern Ethiopia. *Int J Food Sci Agri* c 5(3): 430-439. http://dx.doi.org/10.26855/ijfsa.2021.09.013
7. Monira KN, Salahuddin M, Miah G. 2003. Effect of breed and holding period on egg quality characteristics of chicken. *Int J Poult Sci* 2: 261–263. https://doi.org/10.3923/ijps.2003.261.263
8. Niranjan M, Sharma RP, Rajkumar U, Chatterjee RN, Reddy BLN, et al. 2008. Egg quality traits in chicken varieties developed for backyard poultry farming in India. *Livest Res Rural Dev* 20(12).
9. Hrncar C, Hanusova E, Hanus A, Bujko J. 2014. Effect of genotype on egg quality characteristics of Japanese quali. *Slovak J Anim Sci* 47(1): 6-11.
10. Duan X, Li M, Shao J, Chen H, Xu X, et al. 2018. Effect of oxidative modification on structural and foaming properties of egg white protein. *Food Hydrocolloids* 75(1): 223-228. https://doi.org/10.1016/j.foodhyd.2017.08.008
11. Statistical Analysis Software (SAS). 2016. The Statistical Analysis System. Users Guide for Personal Computer. Version 9.4. SAS Institute Inc., Cary, NC, USA.
12. Tabinda K, Sohail H, Nasir M, Mian A, Tanveer A, et al. 2012. Comparative study of growth performance, egg production, egg characteristics and haemato-biochemical parameters of desi, Fayoumi and Rhode Island red chicken. *J Appl Anim Res* 40: 273-283. https://doi.org/10.1080/09712119.2012.672310
13. Markos S, Belay B, Astatkie T. 2017. Evaluation of egg quality traits of three indigenous chicken ecotypes kept under farmers' management conditions. *Int J Poult Sci* 16: 180-188. https://doi.org/10.3923/ijps.2017.180.188
14. Narushin VG, Romanov MN. 2002. Egg physical characteristics and hatchability. *Worlds Poult Sci J* 58(3): 297-303. https://doi.org/10.1079/WPS20020023
15. Silversides FG, Budgell K. 2004. The relationships among measures of egg albumen height, pH, and whipping volume. *Poult Sci* 83(10): 1619-1623. https://doi.org/10.1093/ps/83.10.1619
16. Sezai A, Aşkın G, Taki K, Kemal K. 2015. Effects of egg weight on egg quality traits in partridge (*Alectoris chukar*). *J Appl Anim Res* 43(4): 450-456. https://doi.org/10.1080/09712119.2014.980419
17. Samson L, Endalew B, Tesfa G. 2013. Production performance of fayoumi chicken breed under backyard management condition in mid rift valley of Ethiopia. *Herald J Agric Food Sci Res* 2(1): 78-81.
18. Radwan LM, Galal A, Shemeis AR. 2015. Prediction of eggshell ultrastructure via some non-destructive and destructive measurements in fayoumi breed. *Asian Australas J Anim Sci* 28(7): 993. https://doi.org/10.5713%2Fajas.14.0847
19. Muhammad JA, Khan SH, Khan AB, Muhammad IA, Muhammad J. 2013. Effect of different storage periods on egg weight, internal egg quality and hatchability characteristics of Fayumi eggs. *Italian J Anim Sci* 12(2): e51. https://doi.org/10.4081/ijas.2013.e51
20. Setsumi M, Mahlehla M. 2020. The effect of egg size (weight) on the eggshell thickness, egg yolk and hatchability in koekoek chickens. *Online J Anim Feed Res* 10(6): 278-281. https://doi.org/10.51227/ojafr.2020.37
21. Thobela LT, Lebogang L, Victoria RH. 2022. Comparative study of egg quality traits between potchefstroom koekoek and hy-line silver brown layers. *Bulg J Agric Sci* 28(1): 145-150.
22. Getnet Z, Mengistu U, Getachew A, Wondmeneh E, Tadelle D. 2020. Comparative laying performance, egg quality, fertility, and hatchability of guinea fowl with tilili, horro and potchefstroom koekoek chicken breeds. *Open J Anim Sci* 10(4): 665-682. https://doi.org/10.4236/ojas.2020.104043
23. Dzungwe JT, Tozo K, Chrysostome CA, Tankouano RA, Oke OE, et al. 2024. Effect of crossbreeding on egg quality, incubation, and hatching activities of the pure and reciprocal cross between the sasso and wassache chickens. *Poult Sci* 103(4): 103406. https://doi.org/10.1016/j.psj.2023.103406
24. Sreenivas D, Prakash MG, Mahender M, Chatterjee RN. 2013. Genetic analysis of egg quality traits in White Leghorn chicken. *Vet World* 6(5): 263. https://doi.org/10.5455/vetworld.2013.263-266
25. Scott TA, Silversides FG. 2000. The effect of storage and strain of hen on egg quality. *Poult Sci* 79(12): 1725-1729. https://doi.org/10.1093/ps/79.12.1725
26. Alemu LT. 2017. Study on the meat and egg quality of different chicken breeds at debrezeit agricultural research center. Addis Ababa University. (Doctoral dissertation)

27. Fanu WM, Melkamu BY, Emana G. 2019. Productivity and egg quality traits of sasso T44 chicken in North Showa Zone, Ethiopia. *J Anim Plant Sci* 39(3): 6478-6486.

28. Tyasi T, Rashijane L, Mokoena K, Molabe K, Mathapo M, et al. 2022. Effects of egg's weight on egg quality traits of the potchefstroom koekoek chicken genotype. *KnE Life Sci* 404–411. https://doi.org/10.18502/kls.v0i0.11825

29. Tesfa G, Usman A. 2018. Production performance evaluation of Koekoek chickens at Adami Tulu research centre. *Afr J Agric Res* 13(35): 1852-1856. https://doi.org/10.5897/ajar2017.12473

30. Desalew T, Harpal S, Ashenafi M, Wondimeneh E, Tadelle D. 2013. Study on productive performances and egg quality traits of exotic chickens under villa production system in East Shewa, Ethiopia. *Afr J Agric Res* 8(13): 1123-1128. https://doi.org/10.5897/AJAR2013.6987

31. Rath PK, Mishra PK, Mallick BK, Behura NC. 2015. Evaluation of different egg quality traits and interpretation of their mode of inheritance in white leghorns. *Vet World* 8(4): 449. https://doi.org/10.14202%2Fvetworld.2015.449-452