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 Koekekoek, 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 Koekekoek 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-
vperimental 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 weight (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); \(\mu\) = Overall mean; \(B_i\) = Fixed effect of the \(i^{th}\) breed (i = Fayoumi and koekoek); and \(\varepsilon_{ij}\) = 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 Nuruhash 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 19.12 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
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 11.5, and 3.76 cm for the fayoumi breed, while the mean YW 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 \( (p < 0.0001) \) 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 \( (p < 0.0001) \) 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 \( (p < 0.0001) \) 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 \( (p < 0.0001) \) 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 \( (p < 0.0001) \) 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 1:** Descriptive statistic results of egg quality traits for the two exotic chicken breeds.

<table>
<thead>
<tr>
<th>S. No</th>
<th>Trait (unit)</th>
<th>Label</th>
<th>Fayoumi</th>
<th>Koekoek</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Mean</td>
<td>CV</td>
<td>Mean</td>
</tr>
<tr>
<td>1</td>
<td>Albumen height</td>
<td>AH</td>
<td>6.6</td>
<td>20.2</td>
</tr>
<tr>
<td>2</td>
<td>Albumen weight</td>
<td>AW</td>
<td>26.0</td>
<td>11.5</td>
</tr>
<tr>
<td>3</td>
<td>Egg length</td>
<td>EL</td>
<td>5.0</td>
<td>6.0</td>
</tr>
<tr>
<td>4</td>
<td>Egg weight</td>
<td>EW</td>
<td>44.3</td>
<td>9.4</td>
</tr>
<tr>
<td>5</td>
<td>Egg width</td>
<td>EWi</td>
<td>3.8</td>
<td>6.1</td>
</tr>
<tr>
<td>6</td>
<td>Shell weight</td>
<td>SW</td>
<td>4.0</td>
<td>19</td>
</tr>
<tr>
<td>7</td>
<td>Yolk color</td>
<td>YC</td>
<td>1.4</td>
<td>39.3</td>
</tr>
<tr>
<td>8</td>
<td>Yolk height</td>
<td>YH</td>
<td>14</td>
<td>7.9</td>
</tr>
<tr>
<td>9</td>
<td>Yolk weight</td>
<td>YW</td>
<td>14.3</td>
<td>11.5</td>
</tr>
<tr>
<td>10</td>
<td>Haugh unit</td>
<td>HU</td>
<td>85.8</td>
<td>9.5</td>
</tr>
</tbody>
</table>

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

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

**Note:** CV = Coefficient of variation.
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.

Acknowledgements

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Conflict of Interest

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

References

Comparative Evaluation of Egg Quality Traits in Two Exotic Chicken Breeds

Mummed et al.


