Effect of breed, age and storage period on egg weight, egg weight loss and chick weight of commercial broiler breeders raised in Saudi Arabia

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Abstract A total of 1350 hatching eggs were obtained from commercial broiler breeders Cobb, Ross 308 and Arbor Acres at 30–35, 40–45 and 50–55 weeks of age, 450 eggs for each breed and 150 eggs for each breed age. Eggs for each age were randomly divided into three groups, 50 eggs in each, stored either for 0, 7 or 14 days, individually weighed before and after storage and incubated following usual hatchery practices. Individual chick weight was recorded at hatch and chick weight percent of fresh egg weight was calculated and data were statistically analyzed. Ross, young breeders and eggs stored for 14 days had the lowest (P<0.05) egg weight whereas Arbor Acres, young breeders and hatching eggs stored for 14 days showed the highest (P<0.05) egg weight loss percent. Cobb, old breeders and fresh hatching eggs had the highest (P<0.05) chick weight while Ross, old breeders and fresh hatching eggs showed the highest (P<0.05) chick weight percent of fresh egg weight.

From the results of the study we conclude that there are significant breeds' differences with respect to all studied traits. Arbor Acres was inferior to Cobb and Ross in most studied traits. The results also showed that advancing breeders' age had a positive effect whereas prolonged egg storage period had a negative effect upon all studied traits.

1. Introduction

Several investigators reported that egg weight increased with advancing age of broilers' breeders (Mather and Laughlin, 1979; Roque and Soares, 1994; Tona et al., 2001, 2003; Yildirim, 2005; Vieira et al., 2005). Zakaria et al. (2009) reported that egg weight loss during incubation increased with advancing age of broilers' breeders which is due to deterioration in shell quality. However, Roque and Soares (1994) noticed that weight loss percent during incubation was higher for eggs produced by young breeders than that of eggs produced by old
breeders disregarding shell thickness. Chick weight increased with advancing age of broilers’ breeders as reported by Yildirim (2005), Vieira et al. (2005) and Christensen et al. (2002), whereas Trehan and Bajwa (2001) did not notice any significant difference in chick weight of 42 and 50 weeks old breeders. Similar results were reported by Reijrink et al. (2010) for eggs stored for 4 and 14 days before incubation but the author noticed that egg weight loss percent during storage was significantly higher for eggs stored for 14 days. Similar results were also reported with respect to ostrich eggs stored for 35 (Hassan et al., 2005), Red legged partridge (Alectoris rufa) eggs stored for 35 (Gonzalez-Redondo, 2010) and white and brown shelled commercial eggs stored for 20 days (Alsobayel and Albadry, 2011). However, there is sparse information regarding commercial broilers’ breeders raised under local conditions, therefore the study was conducted to assess the effect of breed, age of breeder and storage period on egg weight, egg weight loss, chick weight at hatch and chick weight percent of fresh egg weight.

2. Material and methods

A total of 1350 hatching eggs were obtained from commercial broiler breeders Cobb, Ross 308 and Arbor Acres at 30–35, 40–45 and 50–55 weeks of age, 450 eggs for each breed and 150 eggs for each breed age. Hatching eggs for each age were randomly divided into three groups, 50 eggs in each. Eggs in each group were stored either for 0, 7 or 14 days under 75–80% relative humidity and 14–16 °C. Eggs were transformed to the hatcher where temperature was 37 °C and relative humidity was 65%. The trays were designed to separate hatching chicks and do not allow them to move from their places and mix. Hatched chicks were individually weighed and chick weight percent of fresh egg weight was calculated. Data obtained were subjected to statistical analysis using the General Linear Models procedures of SAS Institute (SAS, 1998) using the following statistical model:

\[ Y_{ijkl} = \mu + B_i + A_j + S_k + BA_{ij} + BS_{ik} + AS_{jk} + \cdots + BAS_{ijk} + \epsilon_{ijkl} \]

where \( Y_{ijkl} \) is the \( l \)th observation of \( i \)th breed (\( B \)), the \( j \)th breeder’s age (\( A \)) and \( k \)th storage period (\( S \)). \( BA_{ij} \) is the interaction between breed and breeder’s age and \( BS_{ik} \) is the interaction between breed and storage period and \( AS_{jk} \) is the interaction between breeder’s age and storage period. \( \mu \) is the general mean and \( \epsilon_{ijkl} \) is the random error associated with \( Y_{ijkl} \) observation. Chick weight percent of fresh egg weight was transformed to arc sin \( \sqrt{\text{proportion}} \) prior to statistical analysis. When the analysis of variance indicated the presence of significant differences between breeds, ages or storage period, means were separated using the least significant difference (LSD) test.

### Table 1

<table>
<thead>
<tr>
<th>Breed (B)</th>
<th>Egg weight (g)</th>
<th>Egg weight loss (%)</th>
<th>Chick weight (g)</th>
<th>Chick weight (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arbor Acres</td>
<td>64.6a</td>
<td>1.21a</td>
<td>44.5c</td>
<td>68.1c</td>
</tr>
<tr>
<td>Cobb</td>
<td>64.7a</td>
<td>1.08b</td>
<td>45.4a</td>
<td>69.5b</td>
</tr>
<tr>
<td>Ross</td>
<td>63.7b</td>
<td>1.09b</td>
<td>44.9b</td>
<td>69.7b</td>
</tr>
<tr>
<td>Age (A)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30–35</td>
<td>59.3c</td>
<td>1.19a</td>
<td>41.4e</td>
<td>68.9b</td>
</tr>
<tr>
<td>40–45</td>
<td>64.8b</td>
<td>1.11b</td>
<td>44.9b</td>
<td>68.7e</td>
</tr>
<tr>
<td>50–55</td>
<td>68.9c</td>
<td>1.08b</td>
<td>48.4a</td>
<td>69.7b</td>
</tr>
<tr>
<td>Storage period (S)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>65.0a</td>
<td>0.00a</td>
<td>45.5a</td>
<td>70.0a</td>
</tr>
<tr>
<td>7</td>
<td>64.3b</td>
<td>1.12b</td>
<td>44.8b</td>
<td>69.0b</td>
</tr>
<tr>
<td>14</td>
<td>63.8b</td>
<td>2.26a</td>
<td>44.5b</td>
<td>68.3c</td>
</tr>
<tr>
<td>SEM</td>
<td>0.06</td>
<td>0.012</td>
<td>0.06</td>
<td>0.05</td>
</tr>
<tr>
<td>Source of variation</td>
<td>Probability</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breeds</td>
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<tr>
<td>Age</td>
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<td>**</td>
</tr>
<tr>
<td>Storage period</td>
<td>**</td>
<td>**</td>
<td>**</td>
<td>**</td>
</tr>
<tr>
<td>A × B</td>
<td>**</td>
<td>**</td>
<td>NS</td>
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</tr>
<tr>
<td>S × B</td>
<td>NS</td>
<td>**</td>
<td>NS</td>
<td>**</td>
</tr>
<tr>
<td>S × A</td>
<td>NS</td>
<td>*</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>S × A × B</td>
<td>NS</td>
<td>**</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

**Highly significant (\( P \leq 0.01 \)), *significant (\( P \leq 0.05 \)), NS, not significant.**

\( ab^c \) Means in the same column with different superscripts differ significantly (\( P \leq 0.05 \)).
3. Results

3.1. Egg weight

As it is indicated in Table 1 egg weight was significantly \((P \leq 0.01)\) affected by breed \((B)\), breeder’s age \((A)\), storage period \((S)\) and \(B \times A\) interaction. Arbor Acres and Cobb had statistically similar egg weight whereas Ross had significantly \((P \leq 0.05)\) the lowest value. Old breeders and fresh hatching eggs had significantly \((P \leq 0.05)\) the highest egg weight whereas young breeders and hatching eggs stored for 14 days had the lowest egg weight. Egg weight of Cobb was significantly \((P \leq 0.05)\) the lowest at 30–35 and the highest at 40–45 weeks of age whereas that of Ross was significantly \((P \leq 0.05)\) the lowest at 40–45 and 50–55 weeks of age (Fig. 1).

3.2. Egg weight loss

Egg weight loss percent was significantly \((P \leq 0.01)\) affected by breed, breeder’s age, storage period and all interactions (Table 1). Arbor Acres and young breeders had significantly \((P \leq 0.05)\) the highest egg weight loss percent compared with other breeds and age groups, respectively. On the other hand, hatching eggs stored for 14 days had significantly \((P \leq 0.05)\) the highest and fresh eggs had the lowest, weight loss percent. Ross had significantly \((P \leq 0.05)\) the highest and the lowest egg weight loss percent at 30–35 and 40–45 weeks of age, respectively while Arbor Acres had significantly \((P \leq 0.05)\) the highest egg weight loss at 50–55 weeks of age (Fig. 2). Hatching eggs of Arbor Acres stored for 14 days had significantly \((P \leq 0.05)\) the highest egg weight loss percent (Fig. 3), whereas those of young breeders had the highest value (Fig. 4).

3.3. Chick weight

As it is shown in Table 1 chick weight at hatch was significantly \((P \leq 0.01)\) affected by breed, breeder’s age, storage period and \(B \times A\) interaction. Cobb and old breeder had significantly \((P \leq 0.05)\) the highest whereas Arbor Acres and young breeders had the lowest chick weight. Fresh eggs had significantly \((P \leq 0.05)\) higher chick weight than eggs stored for 7 and 14 days which had statistically similar chick weight. Ross Cobb had significantly the highest chick weight at 30–35 and 40–45 weeks of age, respectively (Fig. 5).

3.4. Chick weight percent

Chick weight percent of fresh egg weight was significantly \((P \leq 0.01)\) affected by breed, breeder’s age, storage period and \(B \times A\) interaction. Arbor Acres and young breeders had significantly \((P \leq 0.05)\) the highest chick weight percent compared with other breeds and age groups, respectively. On the other hand, hatching eggs stored for 14 days had significantly \((P \leq 0.05)\) the highest and fresh eggs had the lowest, weight loss percent. Ross had significantly \((P \leq 0.05)\) the highest and the lowest egg weight loss percent at 30–35 and 40–45 weeks of age, respectively while Arbor Acres had significantly \((P \leq 0.05)\) the highest egg weight loss at 50–55 weeks of age (Fig. 2). Hatching eggs of Arbor Acres stored for 14 days had significantly \((P \leq 0.05)\) the highest egg weight loss percent (Fig. 3), whereas those of young breeders had the highest value (Fig. 4).
Similar results were reported by several investigators with respect to egg weight percent of fresh egg weight increased and egg weight loss increased with prolonged hatching eggs storage period. Our results with respect to the effect of storage period on egg weight loss percent agree with those of Hassan et al. (2005), Reijrink et al. (2010), Gonzalez-Redondo (2010) and Alsobayel and Albadry (2011). The results also showed a significant breed × age interaction on all studied traits except chick weight percent and breed × storage period interaction was significant only on egg weight loss. Cobb ranked first in egg and chick weight with advancing age of breeders followed by Ross with respect to chick weight, whereas Arbor Acres and Ross ranked first at early age in egg weight and chick weight, respectively. Arbor Acres showed the highest egg weight loss with advancing age whereas Ross had the highest and the lowest egg weight loss at early and middle age, respectively. This might be due to the fact that shell quality deterioration is higher with advancing age for Arbor Acres compared to other breeds. Arbor Acres showed the highest egg weight loss and the lowest in chick weight percent for fresh and stored hatching eggs, whereas Ross and Cobb were better in chick weight percent for not stored and stored eggs for 7 days, respectively. Egg weight loss was the highest for stored hatching eggs of young breeders which might be due to their smaller size and larger surface area.

4. Discussion

The results indicated a significant (P ≤ 0.01) breed, age and storage period effect upon all studied traits. Arbor Acres was significantly (P ≤ 0.05) inferior to both breeds in all studied traits except egg weight whereas Cobb had significantly (P ≤ 0.05) higher egg and chick weight and less chick weight percent of fresh egg than Ross. Several investigators reported breed differences with respect to egg weight (Alsobayel and Albadry, 2011; Anderson et al., 2004; Monira et al., 2003; Alsobayel et al., 2003; Harms and Hassein, 1993; Hussein et al., 1993). The results also indicated that egg and chick weight and chick weight percent of fresh egg weight increased and egg weight loss percent decreased with advancing age of breeders. Similar results were reported by several investigators with respect to egg weight increase with advancing age of breeders (Mather and Laughlin, 1979 Roque and Soares, 1994; Yildirim, 2005; Vieira et al., 2005; Zakaria et al., 2009). The results also indicated that egg and chick weight and chick weight percent of fresh egg decreased and egg weight loss increased with prolonged hatching eggs storage period. Our results with respect to the effect of storage period on egg weight loss percent agree with those of Hassan et al. (2005), Reijrink et al. (2010), Gonzalez-Redondo (2010) and Alsobayel and Albadry (2011). The results also showed a significant breed × age interaction on all studied traits except chick weight percent and breed × storage period interaction was significant only on egg weight loss. Cobb ranked first in egg and chick weight with advancing age of breeders followed by Ross with respect to chick weight, whereas Arbor Acres and Ross ranked first at early age in egg weight and chick weight, respectively. Arbor Acres showed the highest egg weight loss with advancing age whereas Ross had the highest and the lowest egg weight loss at early and middle age, respectively. This might be due to the fact that shell quality deterioration is higher with advancing age for Arbor Acres compared to other breeds. Arbor Acres showed the highest egg weight loss and the lowest in chick weight percent for fresh and stored hatching eggs, whereas Ross and Cobb were better in chick weight percent for not stored and stored eggs for 7 days, respectively. Egg weight loss was the highest for stored hatching eggs of young breeders which might be due to their smaller size and larger surface area.

5. Conclusion

From the results of the study reported herein and under the experiment conditions, we conclude that there are significant breeds’ differences with respect to egg weight, egg weight loss percent, chick weight at hatch and chick weight percent of fresh egg weight. Arbor Acres was inferior to Cob and Ross in most studied traits. The results also showed that advancing breeders’ age had a positive effect, whereas prolonged hatching eggs storage period had a negative effect, upon all studied traits and the adverse effect was more pronounced when the hatching eggs stored for more than 7 days.

References

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