Effect of Hen Weight on Egg Production and Some Egg Quality Characteristics in the Partridge (*Alectoris graeca*)

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ABSTRACT A study was conducted to determine the effect of live weight of partridges on egg production and egg quality characteristics. A total of 144 Rock Partridges were divided into control, heavy, middle, and light BW groups at 32 wk of age. Live weights averaged 512.78 g for the control group, 576.18 g for the heavy group, 523.49 g for the middle group, and 473.83 g for the light group. Egg production rates of these groups were 41.44, 45.78, 32.38, and 24.67%, respectively, over an 8-wk period ($P < 0.05$). Live weight significantly affected egg weight, specific gravity, albumen index, shell weight, shell thickness, Haugh unit, and albumen weight ($P < 0.05$). Live weight did not affect the shape index, membrane weight, or yolk weight. As a result, the live weights of partridges used for breeding should not be under the average live weights of hens of the stock. On the other hand, other important factors that affect the egg quality of partridges should be investigated.

Key words: partridge, live weight, egg production, egg quality

INTRODUCTION

Partridges are economically important because they are exploited for hunting tourism. A considerable amount of revenue is gained from partridges bred and released into special hunting grounds.

Kırıkcı et al. (1999) obtained a 43.84% egg production rate in a group of Rock Partridges subjected to artificial lighting and 38.45% in a group maintained under natural lighting conditions. Rock Partridge egg weights range between 19.16 and 22.50 g (Woodard et al., 1982; Kırıkcı et al., 1999; Kırıkcı et al., 2004b).

The evaluation of eggshell quality characteristics has been well documented for domestic fowl (Yannakopoulos and Tserveni-Gousi, 1986; Poyraz, 1989; Tserveni-Gousi and Yannakopoulos, 1990; Scott and Silversides, 2000) and pheasants (Song et al., 2000; Kırıkcı et al., 2004a). However, information concerning the evaluation of shell quality in partridges is limited. Song et al. (2000) indicated that the shape index of partridge eggs is 78.00 and eggshell thickness is 0.232 mm. The important role of partridges as game birds and the problems associated with hatchability, which may be due to the shell quality, indicate the need for more detailed research in this area. Sufficient information on quality characteristics of partridge eggs could not be found in the literature. This study was designed to demonstrate the effects of partridge live weights on egg production and quality characteristics and to determine some of the quality characteristics of partridge eggs.

MATERIALS AND METHODS

Animals and Husbandry

Rock Partridges produced in the Veterinary Faculty Research and Application Farm of Selçuk University were used. Partridge chicks ($n = 450$) of both sexes combined were reared in environmentally controlled housing units from hatch to 12 wk of age, then reared outside in 3 range pens (4 m width $\times$ 4 m length $\times$ 2.5 m height) until they were moved into the breeding units at 32 wk of age. The chicks were fed a starter diet containing 28% CP from hatch to 12 wk of age, then reared in 3 range pens (4 m width $\times$ 4 m length $\times$ 2.5 m height) until they were moved into the breeding units at 32 wk of age. The chicks were fed a starter diet containing 28% CP from hatch to 5 wk of age, a 24% CP diet from 5 to 12 wk of age, and a 16% CP diet from 12 to 32 wk of age. Sex was determined at 32 wk of age. A total of 36 female partridges were randomly selected from the flock and used as the control group. The remaining females were weighed and separated into light, middle, and heavy groups according to BW ($n = 36$ females per group). The live weights of each group at 32 wk of age are shown in Table 1.

The partridges were placed at random in metal wire cages measuring 30 $\times$ 40 $\times$ 30 cm (width, length, height) having 4 floors with 4 divisions in each floor, in groups of 2 hens in each division. The group in each cage was identified and 12 h of daily lighting was provided. Lighting was increased by 1 h/wk and kept constant when 16 h of light/d was reached. During the laying period, a ration constituting 24% CP was given to the partridges ad libitum. Water was provided from automatic water cups.

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Received January 4, 2007.
Accepted March 21, 2007.
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Table 1. Live weights of the female partridge at 32 wk of age (mean ± SE)

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>Live weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>36</td>
<td>512.78 ± 8.15b</td>
</tr>
<tr>
<td>Heavy</td>
<td>36</td>
<td>576.18 ± 25.20a</td>
</tr>
<tr>
<td>Middle</td>
<td>36</td>
<td>523.49 ± 2.23a</td>
</tr>
<tr>
<td>Light</td>
<td>36</td>
<td>473.83 ± 3.80a</td>
</tr>
</tbody>
</table>

*Means designated with different superscripts within the same column are significantly different (P < 0.05).

**Egg Quality Analyses**

The first egg was obtained during wk 34 in all groups. The eggs obtained from the partridges were collected and recorded daily during the weekly research period from 34 to 41 wk of age. To determine egg quality characteristics, 40 partridge eggs from each group were used at 38 wk of age. The specific gravities of the eggs were determined the same day and were obtained by using the formula according to the Archimet method (Hempe et al., 1988): specific gravity = weight in air (g)/[weight in water (g)].

The short and long diameters of the eggs were measured by a digital caliper with a sensitivity of 0.001 mm to determine the shape index. The eggs were then broken one by one on a flat surface, with a waiting period of 5 min. The heights of the yolk and albumen, the long and short diameters of the albumen, and the diameter of the yolk were measured using the caliper. The yolks separated from the albumen were weighed and the weights were recorded. The shells of the broken eggs were washed under gently flowing tap water to release albumen residues, and were then air-dried and weighed. The shell thicknesses at the equator, blunt edge, and pointed edge were measured using the caliper. From the values obtained, the following data were calculated using the formula shown below (Yannakopoulos and Tserveni-Gousi, 1986):

- **shape index** = short edge/long edge × 100
- **yolk index** = yolk height/yolk diameter × 100
- **albumen index** = albumen height/(long diameter of albumen + short diameter of albumen/2) × 100

Table 2. Mean egg production and external egg quality characteristics of groups of Rock Partridges according to live weight (mean ± SE)

<table>
<thead>
<tr>
<th>Group</th>
<th>Egg production rate (%)</th>
<th>Egg weight (g)</th>
<th>Shape index</th>
<th>Specific gravity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>41.44 ± 2.63a</td>
<td>22.36 ± 0.28b</td>
<td>77.56 ± 0.73</td>
<td>0.940 ± 0.003a</td>
</tr>
<tr>
<td>Heavy</td>
<td>45.78 ± 3.65a</td>
<td>23.72 ± 0.19a</td>
<td>76.09 ± 0.70</td>
<td>0.936 ± 0.002ab</td>
</tr>
<tr>
<td>Middle</td>
<td>32.38 ± 2.51b</td>
<td>22.03 ± 0.25c</td>
<td>76.96 ± 0.60</td>
<td>0.932 ± 0.001b</td>
</tr>
<tr>
<td>Light</td>
<td>24.67 ± 3.12b</td>
<td>21.52 ± 0.27c</td>
<td>77.28 ± 0.70</td>
<td>0.934 ± 0.001b</td>
</tr>
</tbody>
</table>

*Means designated with different superscripts within the same column are significantly different (P < 0.05). *n = 40.

**Statistical Methods**

Analysis of variance was used to determine the significance of differences between egg production and egg quality characteristics of the various groups. The significance of the differences among the groups was determined by Duncan’s multiple range test (Petrie and Watson, 1999). Statistical analysis was done using the SPSS 11.0 program package (SPSS Inc., Chicago, IL).

**RESULTS AND DISCUSSION**

Table 2 shows egg production rates, egg weights, shape indexes, and specific gravities of the eggs. Table 3 shows internal egg quality characteristics. Table 4 shows the mean percentages of shell weight, yolk weight, and albumen weight of the groups.

As noted in Table 2, the weight of the hen affected the egg production rate, egg weight, and specific gravity (P < 0.05). Heavy eggs were obtained from the heavy group and light eggs were obtained from the light group. There was no difference among the groups with respect to the shape index of eggs. The specific gravity of eggs obtained from the control group was found to be different from the specific gravities of the middle and light groups (P < 0.05).

As noted in Table 3, there were no differences among the groups with respect to yolk index, but hen weight was found to affect the albumen index (P < 0.05). The shell weight and albumen weight of eggs obtained from the heavy group were greater than the corresponding values for eggs from the control, middle, and light groups. There was no group difference with respect to membrane weight. Shell thickness of the groups was thickest in the control group and thinnest in the light group. There was no difference among the groups with respect to both membrane weight and membrane thickness. With respect to...
to the important criterion of Haugh unit to determine egg quality; the maximum value was 86.65, obtained from the light group, and the minimum value was 83.26, obtained from the heavy group. These groups did not differ with respect to yolk weight.

The BW of the hen was found to affect the mean percentage of shell weight, yolk weight, and albumen weight (P < 0.05). The maximum percentage of shell weight (10.52%) was obtained from the middle group, whereas the maximum percentage of yolk weight (39.02%) was obtained from the light group and the maximum percentage of albumen weight (53.55%) was obtained from the heavy group.

As noted in Table 2, the effect of hen BW on egg production was significant (P < 0.05). Egg production of the control and heavy groups was higher than that of other groups (P < 0.05). This finding supports the recommendation of Çetin and Kirıkçı (2000) for partridges, which necessitates the selection of females with heavy live weights for breeding. However, the average live weights of the middle and control groups were similar to each other; accordingly, hen BW alone did not explain the significance of group differences in egg production. The difference in egg production between these 2 groups may be due to genotype differences of the individuals within the groups. In the present study, egg production was followed for 8 wk, representing half the typical laying period of partridges, as reported by Kirıkçı et al. (1999). Egg production obtained from the heavy and control groups was similar to the values of 40.53, 48.79, and 44.85% reported by Çetin (2002) for partridges mated at male-female rates of 1:3, 1:4, and 1:5, and to those of 38.45 and 43.84% reported by Kirıkçı et al. (1999). However, egg production of the light and middle groups was lower than the values reported by Çetin (2002) and Kirıkçı et al. (1999).

Table 2 shows the effect of female weight on egg weight. Although the heaviest eggs were obtained from the heavy group, the lightest eggs were obtained from females having a light BW (P < 0.05). When we bear in mind the high positive correlation between egg weight and chick weight (Shanawany, 1987; Tserveni-Gousi and Yannakopoulos, 1990), it is recommended that breeders of broiler-type partridges select heavy eggs and, consequently, for the females to have heavy live weights. In contrast, for companies breeding partridges for the purpose of providing game birds as hunting stock, it is advised to obtain light partridges for better flying capability by applying selection to females having light live BW. In the present study, the egg weights obtained from all the groups were found to be higher than the usual partridge egg weights reported in previous studies (Woodard et al., 1982; Yannakopoulos, 1992; Çetin et al., 1997; Kirıkçı et al., 1999). This may be due to the high live weights of the female partridges used in this research.

Although the shape index was found to be the lowest (76.09) in the heavy group, there was no difference among the groups. The shape indexes obtained had values similar to the 78.00 reported by Song et al. (2000) for partridges. The specific gravities of the eggs in the different groups ranged between 0.932 and 0.940, and there seemed to be little variation among the specific gravities of the eggs between groups. The reason for this lack of variation may be that the partridges from which the eggs were obtained were of the same age, and that care and feeding were applied under the same environmental conditions.

### Table 3. Mean internal egg quality characteristics of groups of Rock Partridges according to the live weight (mean ± SE)

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control</th>
<th>Heavy</th>
<th>Middle</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yolk index</td>
<td>47.97 ± 0.61</td>
<td>48.38 ± 0.84</td>
<td>46.12 ± 1.02</td>
<td>47.02 ± 0.55</td>
</tr>
<tr>
<td>Albumen index</td>
<td>1.43 ± 0.06</td>
<td>1.51 ± 0.05</td>
<td>1.58 ± 0.04</td>
<td>1.63 ± 0.04</td>
</tr>
<tr>
<td>Shell weight (g)</td>
<td>2.23 ± 0.06</td>
<td>2.45 ± 0.05</td>
<td>2.33 ± 0.04</td>
<td>2.24 ± 0.04</td>
</tr>
<tr>
<td>Shell membrane weight (g)</td>
<td>0.45 ± 0.02</td>
<td>0.48 ± 0.01</td>
<td>0.48 ± 0.02</td>
<td>0.45 ± 0.01</td>
</tr>
<tr>
<td>Shell thickness (mm)</td>
<td>0.223 ± 0.007</td>
<td>0.212 ± 0.006</td>
<td>0.213 ± 0.005</td>
<td>0.202 ± 0.005</td>
</tr>
<tr>
<td>Shell membrane thickness (mm)</td>
<td>0.004 ± 0.0003</td>
<td>0.003 ± 0.0002</td>
<td>0.004 ± 0.0001</td>
<td>0.003 ± 0.0002</td>
</tr>
<tr>
<td>Haugh unit</td>
<td>84.23 ± 0.85</td>
<td>83.26 ± 0.75</td>
<td>85.37 ± 0.81</td>
<td>86.65 ± 0.29</td>
</tr>
<tr>
<td>Yolk weight (g)</td>
<td>8.19 ± 0.15</td>
<td>8.57 ± 0.12</td>
<td>8.31 ± 0.14</td>
<td>8.40 ± 0.19</td>
</tr>
<tr>
<td>Albumen weight (g)</td>
<td>11.94 ± 0.26</td>
<td>12.70 ± 0.13</td>
<td>11.54 ± 0.19</td>
<td>10.88 ± 0.20</td>
</tr>
</tbody>
</table>

**Note:** Internal egg quality characteristics with different superscripts in the same row are significantly different (P < 0.05).

**Table 4. Mean percentage of shell weight, yolk weight, and albumen weight of groups of Rock Partridges according to live weight (mean ± SE)**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control</th>
<th>Heavy</th>
<th>Middle</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shell weight</td>
<td>9.95 ± 0.21</td>
<td>10.32 ± 0.14</td>
<td>10.52 ± 0.19</td>
<td>10.45 ± 0.16</td>
</tr>
<tr>
<td>Yolk weight</td>
<td>36.78 ± 0.73</td>
<td>36.13 ± 0.43</td>
<td>37.04 ± 0.55</td>
<td>39.02 ± 0.69</td>
</tr>
<tr>
<td>Albumen weight</td>
<td>53.27 ± 0.76</td>
<td>53.55 ± 0.43</td>
<td>52.37 ± 0.59</td>
<td>50.53 ± 0.69</td>
</tr>
</tbody>
</table>

**Note:** Mean percentage with different superscripts in the same row are different (P < 0.05).

**n = 40.**
The Haugh units of the light group were higher than those of the other groups ($P < 0.05$). The yolk and albumen weights, respectively, were determined to be 8.19 and 11.94, 8.57 and 12.70, 8.32 and 11.54, and 8.40 and 10.88 g in the control, heavy, middle, and light groups. Although the heaviest egg yolks were found in the heavy group, the differences between yolk weights of the different groups were not significant. However, with respect to albumen weights, considerable differences were observed in the values obtained from the groups ($P < 0.05$). Therefore, the differences in egg weights of the groups may be related to the egg albumen weight and eggshell weight, which are the components forming the egg. According to the egg weight, the light group had the heaviest mean percentage of yolk weight ($P < 0.05$). However, the light group had the lowest mean percentage of albumen weight ($P < 0.05$). Other groups had similar values for the mean percentage of albumen weight. Kırıkcı et al. (2004b) reported that eggs of extreme weights (very small and large) had low fertility and that hatchability was disproportionately reduced in eggs that had lost less mass during incubation. The low fertility and hatchability values could have arisen from light eggs having low albumen weights and high yolk weights.

Based on this research, we recommend that the live weights of female partridges to be selected for breeding should not be much lower than the stock average to obtain better egg production from the partridges. Additional research is needed to determine other factors affecting partridges, for example, the effects of age and egg characteristics besides female weights.

**ACKNOWLEDGMENT**

We want to thank the Selçuk University Research Foundation for supporting this study.

**REFERENCES**


