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# The Effect of Hatching System and Egg Weight on Production Traits in Turkish Geese: Growth Performance, Slaughter and Meat Quality Traits

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A B S T R A C T

This study was aimed to determine the effect of hatching system (house and machine) and egg weight (heavy and light) on growth performance and meat quality traits in geese. The study was carried out for 12 weeks with a total of 220 Turkish native geese. The geese were individually weighed every 2 weeks during the study, on these same weeks feed conversion ratio (FCR) was measured. Hot and cold dressed, blood, head, foot, edible internal organs (heart, liver, gizzard), abdominal fat, neck, back, breast, thigh and wing percentages were determined. Also cooking loss, drip loss, color and pH were determined as meat quality traits. There was no significant difference between the egg weight groups in terms of BW. However, the geese produced in the house hatching system showed more BW from 6 to 12 weeks of age onwards compared to the machine system. There was no significant difference between the groups in terms of FCR by 8 weeks. Both 10 and 12 weeks FCR were determined as the worst house heavy, while the best house light groups. Hot and cold carcass percentages in geese hatched from heavy were higher rates than light eggs. The percentage of wings differed significantly among geese produced from different egg weight groups. Breast meat cooking loss was found higher rates in heavy eggs than light eggs, while thigh meat cooking loss was found higher rates in the house than machine system. The results of this study show that geese hatched in the house system had more BW at the slaughter age compared to machine system geese. In addition, geese produced from heavy eggs showed a higher hot and cold dressed percentages than geese produced from light eggs.

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## Introduction

There are few companies in the world working on commercial breeding of goose and especially China and Eastern Europe stand out in goose meat production (Zhu et al. 2011; Abou-Kassem et al. 2018). Goose production in the world, which account for less than 1% of poultry meat consumption in 1960s (Bean and Hanson 1962), in these days, would seem to proffer an opportunity to increase the consumption of poultry products by adding variety to the traditional menu, and it has shown significant growth by efforts entrepreneurs, farmers and researchers studying with species of alternative poultry (Biswas et al., 2019; Boz et al., 2019).

The geese growth is considered to one of the most rapid species in all livestock poultry for meat production (Farrell 2004). Slow growing geese reach a 5-6 kg slaughter weight at 12–16 weeks of age whereas fast growing geese reach a 4-5 kg slaughter weight approximately at 10 weeks of age. The ideal slaughter age is considered to be age of 10-12 weeks, when the free of pinfeathers, the fat content is low and sufficient meat yield is reached (Bean and Hanson 1962; Buckland and Guy 2002; Boz et al., 2017a, b). Like other waterfowl species, geese tend to deposit fat in the body, and therefore their growth also occurs in the skin, feathers, and body fat (Lu et al. 2011; Arroyo et al., 2013). The meat from waterfowls is quite tasty and high nutritional value, so consumers prefer them. Goose meat contain good quantities of fatty acids and essential amino acids (Boz et al., 2019). Goose meat is a significant reservoir of amino acids, small amount of collagen, less calorific than red meat, low cholesterol, and also relatively lower fat content with a higher content of valuable polyunsaturated (PUFA) fatty acid (Okruszek et al., 2013; Buzała et al., 2014; Oz and Celik 2015; Lewko et al., 2017; Orkusz 2018; Boz et al., 2019). The proportion of carcass and the meat quality in poultry depends on many parameters such as genotype, selection level, nutrition, age, production system and gender. The goose meat quality is important for consumers and producers. The carcass quality is analyzed with regard to the weights of different carcass parts, the abdominal fat content, and its general appearance. Additionally, meat quality can be expressed by the water holding capacity, color, cooking loss, drip loss and pH (Kuźniacka et al., 2014; Boz et al., 2017b; Yamak et al., 2018; Sarica et al., 2019; Biesek et al., 2020a; Yamak et al., 2020).

Conventionally hatched hatchlings are exposed to rough environmental conditions such as dust, debris, bacterial and viral load, continuous noise, darkness, handling, vaccination, post-hatch feed and water deprivation and transportation (Archer and Mench 2014; de Gouw et al., 2017; Hollemans et al., 2018). These factors can affect to welfare, health and performance traits in the long-term (Ericsson et al., 2016; Hedlund et al., 2019). Broiler chicks deprived for 28 h or more longer had lower body weights, higher total mortality, as well as the relative weights of intestines (jejunum and ileum) and livers of hatchlings that access to water and feed after 48 h were significantly lower than compared to the earlier access to feed and water (Abed et al., 2011; de Jong et al., 2017; Özlü et al., 2020). In house hatching systems, where hatchlings have immediately access to feed and water after the hatch. There might be reduce stressful environmental conditions for a hatchling in house hatching system (Hollemans et al., 2018; de Jong et al., 2019). Recent studies have reported that the chick quality in the house hatched system was lower, but there was no difference in terms of growth performance compared to machine hatch also and determined better livability and less foot-pad dermatitis in the house system (de Jong et al., 2019, 2020).

In Turkey where goose rearing is common, eggs are generally incubated naturally, especially in rural areas with extensive systems while very few farms use artificial incubation (Boz et al. 2017a). In addition, studies on goose incubation are very limited compared to chicken. Recent studies shows that factors which can effect of the egg characteristics and hatching conditions not only on hatchability and gosling quality but also on growth traits. The objective of our study was to examine the effect of hatching system and egg weight on growth performance, slaughter weight, carcass and meat quality traits in geese.

## Material and Methods

### *Management Procedures and Performance Measurements*

After the hatching process was completed, all the goslings were reared in the intensive system and they were reared on the littered-floor system with straw in 8 cm thickness. A day before the all goslings were transferred to the house, the temperature of house was set 28±1°C and heating was stopped at the 21 d of age. Depending on climatic conditions, 4-12 weeks the average house temperature and relative humidity was provided between 24-26 °C and 55-70% in the house, respectively. After the all goslings placed in the house, 24 h lighting was applied throughout first 3 days. After 4 weeks of age, mechanical ventilation was provided in addition to natural ventilation.

Firstly 3% sugar-water was given to the goslings produced by the house and hatcher system. The goslings that hatching the house had free access to feed and water. They were fed with starter ration from hatching up to 6 weeks of age (%20 CP, 12.02 MJ ME, %6 Crude ash, %4.5 Crude cellulose, %0.34 met., %1.0 lys., %0,810 Ca., %0,30 P.) and grower ration from 7 to 12 weeks of age (%15 CP, 12.56 MJ ME, %5.4 Crude ash, %4.2 Crude cellulose, %0.290 met., %0,670 lys., %0,750 Ca., %0,320 P.). Feed and water were also given ad-libitum for all geese.

Goslings obtained from both hatching systems were placed in the pens as male-female mixed (11 geese/pen) in 5 repetitions for each sub-group after hatching period was ended. The pen sizes were 250×250×350 cm, containing 15 kg tube feeder and one drinker. The wing numbers were attached to the goslings individually, the body weights at 2, 4, 6, 8, 10, 11 and 12 weeks of age were individually weighed with scale in 0.01 g precision. At the same weeks, feed consumption was determined for each pen and feed conversion ratio were calculated as weekly feed consumption/body weight gain.

### *Slaughter and Meat Quality Measurements*

A 12-h fasting period was applied to geese before slaughter and only water was given throughout this duration. Hot carcass, head, feathers, foot, edible inner organs (heart, liver, gizzard) and abdominal fat weights were determined after slaughter and body weights were determined before slaughter. Slaughtered geese were kept in 60°C hot-water for 5 minutes and plucking was done in a semi-automatic plucking machine. Before and after slaughtering and before and after plucking, weights of blood and feathers were determined. The carcasses were kept at +4°C for 24 h, and the weight of the cold carcass and the carcass parts (neck, wing, thigh, breast and back) were determined. The method applied in turkeys was used put carcass in parts, and carcass yield and carcass part ratios were determined (Sarica et al. 2009, 2011). Cooking loss, drip loss, color and pH were determined as meat quality traits. Drip loss and cooking loss in fresh meat samples were made according to Bianchi et al. (2007) and Boz et al. (2017b). Color and pH measurements were made in skinless breast and thigh regions of carcasses kept at +4 °C for 24 h after slaughtering. Color measurements (L*; brightness, a*; redness, b*; yellowness) was determined with a Konika-Minolta CR 400 colors measuring device on three regions of the thigh and breast. PH measurements were made with a pH meter (Model PC 510, Cyber Scan/ Singapore) on the different regions of breast and thigh meat. The average of 3 different regions of breast and thigh meat was taken in determining color and pH values.

### *Statistical Analyses*

The present study was a 2 × 2 × 2 factorial design with 2 hatching system, 2 egg weight and 2 gender treatments. All data analyses were performed by the SPSS software program (Version 20.0, licensed by Ondokuz Mayis University) via a factorial ANOVA using the GLM. Significance was considered at the 0.05 level and multiple comparisons were performed by Duncan test. Data on feed consumption, and feed conversion ratio (FCR) were analysed the following model;

$$Yij = \mu + H_i + W_j + (HW)_{ij} + e_{ij},$$

Where;

$Y_{ij=}$ Is the dependent variable
M= Is the overall mean
$H_{i=}$ Is the hatching system (i = house or hatcher)
$W_{j=}$ Is the egg weight (j = heavy or light)
$HW_{ij=}$ Is the interaction between the hatching system and egg weight
$e_{ij=}$ Is the error term

Data on BW, slaughter and carcass weight, organ ratio, carcass and meat quality traits were analyzed the following model;

$$Y_{ijk} = \mu + H_i + W_j + G_k + (HW)_{ij} + (HG)_{ik} + (WG)_{jk} + (HWG)_{ijk} + e_{ijk}$$

Where;

$Y_{ij=}$ Is the dependent variable
M= Is the overall mean
$H_{i=}$ Is the hatching system (i = house or hatcher)
$W_{j=}$ Is the egg weight (j = heavy or light)
$HW_{ij=}$ Is the interaction between the hatching system and egg weight
$HG_{ik=}$ Is the interaction between the hatching system and gender
$WG_{jk=}$ Is the interaction between the egg weight and gender
$HWG_{ijk=}$ Is the interaction between the hatching system, egg weight and gender
$e_{ijk=}$ Is the error term.

The interactions between the groups were not given in the tables because they were not found to be significant.

**Results and Discussion**

The effect of hatching system, egg weight and gender groups on body weights are shown in Table 1. There were no differences between egg weight groups in terms of BW during the growth period. However, geese hatched in the house were higher than geese hatched in the hatcher from 6 weeks of age to slaughter age (P<0.05). Moreover, similar to hatching system, males were heavier than females from the 6 weeks of age (P<0.05). There was no significant difference between the groups in terms of FCR by 8 weeks (P>0.05). Both 10 and 12 weeks FCR were determined as the worst house heavy, while the best house light groups (P<0.05; data not shown).

The effect of hatching system, egg weight and gender groups on slaughter and carcass weights are shown in Table 2. As expected in terms of slaughter weight, there were differences according to hatching system (P<0.05) and gender (P<0.01), but not according to egg weight groups (P>0.05). In the house system, although the hot and cold carcass weights were heavier than the hatcher (P<0.01), there was no difference between the systems in terms of ratio (P>0.05). It was determined that geese obtained from heavy eggs were heavier than those obtained from light eggs in terms of hot carcass weight (P<0.05) and cold carcass weight (P<0.10). With regards to carcass ratios, geese obtained from heavy eggs provided an advantage (P<0.05). The carcasses obtained from male geese were found to had higher averages than females in terms of both weight and proportion (P<0.01).

The effect of hatching system, egg weight and gender groups on some organ rates are shown in Table 3. There was no difference between hatching system and egg weight groups in blood, head, foot, heart, liver and gizzard ratios (P>0.05).

Table 1. Growth performance of hatching system, egg weight and gender groups

| | | | Growing Period (weeks) g | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HS[1] | EW[2] | G[3] | 2 | 4 | 6 | 8 | 10 | 11 | 12 |
| House | Heavy | F[4] | 436.1 | 854.5 | 1814.8 | 2814.1 | 3232.1 | 3269.0 | 3417.8 |
| | | M[5] | 441.8 | 901.6 | 2012.7 | 3196.0 | 3665.1 | 3683.2 | 3869.1 |
| | Light | F | 427.7 | 801.6 | 1873.3 | 2909.0 | 3368.3 | 3466.1 | 3573.9 |
| | | M | 437.8 | 820.7 | 1990.9 | 3152.9 | 3659.0 | 3703.0 | 3868.9 |
| Hatcher | Heavy | F | 468.4 | 840.1 | 1724.8 | 2816.3 | 3207.3 | 3253.6 | 3480.6 |
| | | M | 433.1 | 844.8 | 1743.5 | 2843.6 | 3304.6 | 3367.1 | 3549.7 |
| | Light | F | 434.5 | 805.5 | 1685.1 | 2608.7 | 3034.6 | 3089.3 | 3445.8 |
| | | M | 502.2 | 946.7 | 2028.2 | 2911.2 | 3491.2 | 3540.0 | 3641.0 |
| SEM | | | 19.449 | 42.525 | 87.624 | 103.39 | 104.56 | 103.97 | 108.17 |
| House | | | 435.8 | 844.6 | $1922.9^a$ | $3018.1^a$ | $3481.1^a$ | $3530.4^a$ | $3692.4^a$ |
| Hatcher | | | 459.6 | 834.2 | $1770.4^b$ | $2794.9^b$ | $3259.4^b$ | $3312.5^b$ | $3519.3^b$ |
| SEM | | | 9.897 | 21.648 | 44.583 | 52.722 | 53.186 | 52.898 | 55.036 |
| Heavy | | | 444.8 | 835.2 | 1799.0 | 2917.5 | 3352.3 | 3393.3 | 3579.3 |
| Light | | | 450.5 | 843.6 | 1894.4 | 2895.5 | 3388.3 | 3449.6 | 3632.4 |
| SEM | | | 9.930 | 21.756 | 44.863 | 53.152 | 53.521 | 53.230 | 55.385 |
| Female | | | 441.6 | 825.4 | $1774.5^b$ | $2787.1^b$ | $3210.6^b$ | $3269.5^b$ | $3479.5^b$ |
| Male | | | 453.7 | 853.4 | $1918.8^a$ | $3025.9^a$ | $3530.0^a$ | $3573.3^a$ | $3732.2^a$ |
| SEM | | | 9.915 | 21.684 | 44.681 | 53.184 | 53.307 | 53.013 | 55.157 |
| | | | P-value | | | | | | |
| HS | | | 0.093 | 0.737 | 0.017 | 0.003 | 0.004 | 0.004 | 0.042 |
| EW | | | 0.685 | 0.786 | 0.135 | 0.771 | 0.635 | 0.455 | 0.499 |
| G | | | 0.391 | 0.363 | 0.024 | 0.002 | 0.001 | 0.001 | 0.001 |

[a,b]Means with different superscripts differ significantly (P≤0.05). [1]Hatch System: The eggs were hatched in machine or house. [2]Egg Weight: Heavy ≥ 160 g, Light < 160 g [3]Gender: [4]Female; [5]Male

Table 2. Slaughter and Carcass Weights of hatching system, egg weight and gender groups

| HS[1] | EW[2] | G[3] | Slaughter Weight | Hot Dressed Weight | Cold Dressed Weight | Hot Dressed Ratio | Cold Dressed Ratio |
|---|---|---|---|---|---|---|---|
| House | Heavy | F[4] | 3475.5 | 2054.7 | 2121.3 | 59.1 | 61.02 |
| | | M[5] | 3767.5 | 2298.3 | 2356.5 | 61.0 | 62.56 |
| | Light | F | 3480.1 | 2053.8 | 2110.1 | 59.0 | 60.61 |
| | | M | 3672.1 | 2191.5 | 2251.6 | 59.7 | 61.32 |
| Hatcher | Heavy | F | 3366.7 | 2009.8 | 2032.8 | 59.7 | 60.37 |
| | | M | 3548.1 | 2142.5 | 2211.9 | 60.4 | 62.36 |
| | Light | F | 3307.1 | 1923.5 | 1978.1 | 58.1 | 59.80 |
| | | M | 3566.1 | 2104.3 | 2163.8 | 59.0 | 60.68 |
| SEM | | | 56.607 | 40.543 | 42.005 | 0.618 | 0.655 |
| House | | | 3598.8$^{a}$ | 2149.6$^{a}$ | 2209.9$^{a}$ | 59.7 | 61.38 |
| Hatcher | | | 3447.0$^{b}$ | 2045.0$^{b}$ | 2096.6$^{b}$ | 59.3 | 60.80 |
| SEM | | | 28.304 | 20.271 | 21.003 | 0.309 | 0.327 |
| Heavy | | | 3539.4 | 2126.3$^{a}$ | 2180.6$^{x}$ | 60.06$^{a}$ | 61.58$^{a}$ |
| Light | | | 3506.4 | 2068.3$^{b}$ | 2125.9$^{y}$ | 58.95$^{b}$ | 60.60$^{b}$ |
| SEM | | | 28.304 | 20.271 | 21.003 | 0.309 | 0.327 |
| Female | | | 3407.3$^{b}$ | 2010.4$^{b}$ | 2060.5$^{b}$ | 58.98$^{b}$ | 60.45$^{b}$ |
| Male | | | 3638.5$^{a}$ | 2184.2$^{a}$ | 2245.9$^{a}$ | 60.03$^{a}$ | 61.73$^{a}$ |
| SEM | | | 28.304 | 20.271 | 21.003 | 0.309 | 0.327 |
| | | | | | P-value | | |
| HS | | | 0.023 | 0.001 | 0.001 | 0.377 | 0.221 |
| EW | | | 0.688 | 0.049 | 0.073 | 0.016 | 0.042 |
| G | | | 0.001 | 0.001 | 0.001 | 0.021 | 0.009 |

[a,b]Means with different superscripts differ significantly (P≤0.05). [x,y]Means with different superscripts differ significantly (P≤0.10). [1]Hatching System: The eggs were hatched in machine or house. [2]Egg Weight: Heavy ≥ 160 g, Light < 160 g [3]Gender: [4]Female; [5]Male

Table 3. Some Organ Rates of hatching system, egg weight and gender groups

| HS[1] | EW[2] | G[3] | Blood Ratio | Head Ratio | Foot Ratio | Heart Ratio | Liver Ratio | Gizzard Ratio | Feather Ratio |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | % | | | |
| House | Heavy | F[4] | 13.93 | 3.41 | 2.94 | 1.03 | 2.95 | 5.06 | 5.67 |
| | | M[5] | 11.86 | 3.65 | 3.06 | 0.96 | 2.79 | 6.01 | 4.77 |
| | Light | F | 13.89 | 3.47 | 2.71 | 1.03 | 2.82 | 5.67 | 5.49 |
| | | M | 13.90 | 3.69 | 3.21 | 1.03 | 3.22 | 5.64 | 4.19 |
| Hatcher | Heavy | F | 14.71 | 3.53 | 2.99 | 1.01 | 2.74 | 5.71 | 5.62 |
| | | M | 12.35 | 3.63 | 3.09 | 0.99 | 2.87 | 5.21 | 5.61 |
| | Light | F | 13.95 | 3.64 | 2.98 | 0.97 | 2.68 | 6.10 | 6.27 |
| | | M | 13.90 | 3.65 | 3.03 | 0.99 | 2.77 | 5.04 | 5.47 |
| SEM | | | 0.767 | 0.072 | 0.081 | 0.053 | 0.227 | 0.352 | 0.424 |
| House | | | 13.4 | 3.55 | 2.98 | 1.01 | 2.95 | 5.60 | 5.03$^{b}$ |
| Hatcher | | | 13.7 | 3.61 | 3.02 | 0.99 | 2.76 | 5.52 | 5.75$^{a}$ |
| SEM | | | 0.383 | 0.036 | 0.040 | 0.026 | 0.114 | 0.176 | 0.212 |
| Heavy | | | 13.2 | 3.55 | 3.02 | 1.00 | 2.84 | 5.50 | 5.42 |
| Light | | | 13.9 | 3.61 | 2.98 | 1.01 | 2.87 | 5.61 | 5.36 |
| SEM | | | 0.383 | 0.036 | 0.040 | 0.026 | 0.114 | 0.176 | 0.212 |
| Female | | | 14.1$^{a}$ | 3.52$^{b}$ | 2.92$^{b}$ | 1.01 | 2.80 | 5.64 | 5.76$^{a}$ |
| Male | | | 13.0$^{b}$ | 3.65$^{a}$ | 3.09$^{a}$ | 0.99 | 2.91 | 5.48 | 5.01$^{b}$ |
| SEM | | | 0.383 | 0.036 | 0.040 | 0.026 | 0.114 | 0.176 | 0.212 |
| | | | | | | P-value | | | |
| HS | | | 0.543 | 0.259 | 0.482 | 0.548 | 0.258 | 0.744 | 0.022 |
| EW | | | 0.205 | 0.263 | 0.528 | 0.826 | 0.839 | 0.649 | 0.838 |
| G | | | 0.045 | 0.011 | 0.006 | 0.698 | 0.470 | 0.522 | 0.016 |

[a,b]Means with different superscripts differ significantly (P≤0.05). [1]Hatching System: The eggs were hatched in machine or house. [2]Egg Weight: Heavy ≥ 160 g, Light < 160 g [3]Gender: [4]Female; [5]Male

It had been calculated that female had higher rates than males in terms of blood and feather ratio, but it had been calculated that male had higher rates than females in terms of head and foot ratio (P<0.05). It was determined that geese obtained from the hatcher system had a higher feather ratio compared to those obtained from the house system (P<0.05).

The effect of hatching system, egg weight and gender groups on some carcass rates are shown in Table 4. It was determined that geese hatched from light eggs in terms of wing ratio were higher than those hatched from heavy eggs (P<0.05). There was no difference between treatment groups (P<0.05) in terms of carcass part ratios (neck, back, breast, thigh, wing and abdominal fat ratios).

Table 4. Some Carcass Traits of hatching system, egg weight and gender groups

| HS[1] | EW[2] | G[3] | Neck Ratio | Back Ratio | Breast Ratio | Thigh Ratio | Wing Ratio | Abdominal Fat Ratio |
|---|---|---|---|---|---|---|---|---|
| House | Heavy | F[4] | 8.37 | 24.29 | 26.85 | 21.25 | 19.16 | 4.31 |
| | | M[5] | 8.54 | 23.47 | 28.42 | 20.74 | 19.38 | 3.94 |
| | Light | F | 8.71 | 23.12 | 26.65 | 20.56 | 19.25 | 4.22 |
| | | M | 8.60 | 24.10 | 26.96 | 20.17 | 20.04 | 3.23 |
| Hatcher | Heavy | F | 8.00 | 23.27 | 28.88 | 20.54 | 19.21 | 3.81 |
| | | M | 8.45 | 23.99 | 27.86 | 20.90 | 18.22 | 4.11 |
| | Light | F | 8.95 | 23.02 | 27.18 | 20.81 | 19.93 | 4.27 |
| | | M | 8.90 | 22.85 | 28.13 | 20.62 | 19.51 | 3.95 |
| SEM | | | 0.336 | 0.755 | 0.752 | 0.414 | 0.384 | 0.340 |
| House | | | 8.56 | 23.75 | 27.22 | 20.68 | 19.46 | 3.93 |
| Hatcher | | | 8.57 | 23.28 | 28.01 | 20.72 | 19.22 | 4.03 |
| SEM | | | 0.168 | 0.378 | 0.376 | 0.207 | 0.192 | 0.170 |
| Heavy | | | 8.34[y] | 23.76 | 28.00 | 20.86 | 18.99[b] | 4.04 |
| Light | | | 8.79[x] | 23.27 | 27.23 | 20.54 | 19.68[a] | 3.92 |
| SEM | | | 0.168 | 0.378 | 0.376 | 0.207 | 0.192 | 0.170 |
| Female | | | 8.51 | 23.42 | 27.39 | 20.79 | 19.39 | 4.15 |
| Male | | | 8.62 | 23.60 | 27.85 | 20.61 | 19.29 | 3.81 |
| SEM | | | 0.168 | 0.378 | 0.376 | 0.207 | 0.192 | 0.170 |
| | | | | | P-value | | | |
| HS | | | 0.942 | 0.391 | 0.143 | 0.904 | 0.385 | 0.658 |
| EW | | | 0.064 | 0.370 | 0.154 | 0.289 | 0.015 | 0.612 |
| G | | | 0.629 | 0.738 | 0.396 | 0.532 | 0.711 | 0.160 |

[a,b]Means with different superscripts differ significantly (P≤0.05). [x,y]Means with different superscripts differ significantly (P≤0.10). [1]Hatching System: The eggs were hatched in machine or house. [2]Egg Weight: Heavy ≥ 160 g, Light < 160 g [3]Gender: [4]Female; [5]Male

Table 5. Some Meat Quality Traits of hatching system, egg weight and gender groups

| HS[1] | EW[2] | G[3] | Breast | | | Thigh | | |
|---|---|---|---|---|---|---|---|---|
| | | | Drip Loss | Cooking Loss | pH | Drip Loss | Cooking Loss | pH |
| | | | | | % | | | |
| House | Heavy | F[4] | 3.64 | 19.12 | 6.05 | 2.58 | 12.54 | 6.12 |
| | | M[5] | 3.41 | 22.97 | 6.12 | 2.12 | 14.15 | 6.18 |
| | Light | F | 3.68 | 16.84 | 6.01 | 2.12 | 12.26 | 6.06 |
| | | M | 3.40 | 20.41 | 5.84 | 1.66 | 12.49 | 5.92 |
| Hatcher | Heavy | F | 3.81 | 19.28 | 5.94 | 2.59 | 11.50 | 6.02 |
| | | M | 4.57 | 18.57 | 5.94 | 2.79 | 12.56 | 6.11 |
| | Light | F | 3.53 | 18.64 | 6.11 | 2.32 | 11.01 | 6.16 |
| | | M | 3.28 | 16.22 | 6.09 | 2.10 | 11.38 | 6.13 |
| SEM | | | 0.459 | 1.224 | 0.109 | 0.405 | 0.808 | 0.073 |
| House | | | 3.53 | 19.84 | 6.00 | 2.12 | 12.86[a] | 6.07 |
| Hatcher | | | 3.80 | 18.18 | 6.02 | 2.45 | 11.61[b] | 6.10 |
| SEM | | | 0.229 | 0.612 | 0.054 | 0.202 | 0.404 | 0.037 |
| Heavy | | | 3.86 | 19.99[a] | 6.01 | 2.52 | 12.69 | 6.11 |
| Light | | | 3.47 | 18.03[b] | 6.01 | 2.05 | 11.78 | 6.07 |
| SEM | | | 0.229 | 0.612 | 0.054 | 0.202 | 0.404 | 0.037 |
| Female | | | 3.67 | 18.47 | 6.03 | 2.40 | 11.83 | 6.09 |
| Male | | | 3.67 | 19.54 | 6.00 | 2.17 | 12.65 | 6.09 |
| SEM | | | 0.229 | 0.612 | 0.054 | 0.202 | 0.404 | 0.037 |
| | | | | | P-value | | | |
| HS | | | 0.411 | 0.063 | 0.845 | 0.255 | 0.035 | 0.554 |
| EW | | | 0.240 | 0.029 | 0.984 | 0.107 | 0.122 | 0.463 |
| G | | | 0.999 | 0.221 | 0.714 | 0.417 | 0.159 | 0.962 |

[a,b]Means with different superscripts differ significantly (P≤0.05). [1]Hatching System: The eggs were hatched in machine or house. [2]Egg Weight: Heavy ≥ 160 g, Light < 160 g [3]Gender: [4]Female; [5]Male

The effect of hatching system, egg weight and gender groups on some meat quality traits are shown in Table 5. The thigh meat cooking loss was found to be higher in geese from hatched house than compared to in geese from hatched hatcher, while the breast meat cooking loss was found to be higher in geese from hatched heavy eggs than compared to in geese from hatched light eggs (P<0.05).

The effect of hatching system, egg weight and gender groups on meat color traits are shown in Table 6. It has been determined that both breast and thigh meats in the house have brighter (L*) compared to those that hatch of the hatcher (P<0.05). Breast meat obtained from females were found to be yellower (b*) than males (P<0.05).

The goslings are 2/3 of the egg weight and there is a positive correlation between egg weight and gosling weight. However, this effect may decrease gradually in the following periods, so it did not affect the final weight in our study (Tahir et al. 2011; Türkoğlu and Sarıca 2018).

Kucharska-Gaca et al. (2017) conducted a study where formed different goose egg weight groups such as averages 151 g, 170 g, 188 g and 207 g. Although the researcher reported that the highest body weight was obtained from the heaviest egg group until the 10 weeks of age, there was no significant differences between the groups at 16 weeks of age. In studies conducted out of goose, Ipek and Dikmen (2007) reported that the highest body weight was determined during the 16 weeks rearing period in pheasants hatched from heavier eggs compared with medium and lighters. Duman and Şekeroğlu (2017) reported that the superiority of broiler chicks that hatched from heavier eggs disappeared after the first week of age. Abiola et al. (2008) reported that the best hatchability and post-hatch growth performance from medium-weighted eggs, while the best carcass and meat-bone ratio was in the hatchlings obtained from the heaviest eggs. In our study, although there was no difference in terms of growth period and slaughter weight according to egg weight groups, those obtained from Heavy eggs had higher yields in terms of carcass weights and ratios, which are important criteria for meat production. Neck, wing and breast meat cooking losses were different according to egg weight groups (P<0.05).

Environmental conditions in incubation and after hatch have been reported to have an effect on body, slaughter and carcass weights of poultry (Tona et al., 2004; Akşit et al., 2013; Boz et al., 2017a, b). Furthermore, the goose meat quality traits are important for producers and consumers (Biesek et al., 2020b).

Geese hatching from hatcher (artificially incubation) were found to have higher body weights and better feed conversion rates than naturally hatched geese (Boz et al., 2017a). Artificially hatched geese had higher slaughter weights, carcass weights, carcass ratios, carcass part, feather, edible inner organ weights and abdominal fat was higher in naturally hatched geese (Boz et al., 2017b). In our current study, it has been determined that the hatch house during the hatching period of the artificial incubation, which provides an advantage, contributed to these previous study results in terms of body, slaughter and carcass weights.

Boz et al. (2017b) reported that breast meat pH, L* and a* values were higher in artificially hatched geese, whereas thigh meat b* and pH values were higher in naturally hatched geese. In current study, it has been determined that both breast and thigh meats in the house hatch L* values compared to those that hatch of the hatcher (P<0.05). It has been reported that the transfer of the house from the hatcher the first contact with humans at this time can cause pressure and panic in goslings. In addition, fear can negatively affect body weight gain as it has a detrimental effect on feed conversion ratio (Jones 1987; Romanov 1999). Moreover, since the digestive system of the goslings hatched in the house was better developed (Jin et al., 1998), it could be thought that the gosling's growth performs better in the following weeks in our study.

Body and slaughter weight, carcass and meat quality traits of poultry have been reported to vary with respect to gender (Boz et al., 2017a, b; Sarica et al., 2019, 2021; Yamak et al., 2016, 2018, 2020).

Table 6. Meat Colors of hatching system, egg weight and gender groups

| HS[1] | EW[2] | G[3] | Breast | | | Thigh | | |
|---|---|---|---|---|---|---|---|---|
| | | | L | a | b | L | a | b |
| House | Heavy | F[4] | 42.16 | 9.85 | 2.27 | 46.09 | 7.34 | 2.90 |
| | | M[5] | 44.64 | 9.94 | 1.49 | 42.80 | 8.08 | 2.08 |
| | Light | F | 43.31 | 9.68 | 2.69 | 40.82 | 9.34 | 2.10 |
| | | M | 43.40 | 9.51 | 2.10 | 42.46 | 8.71 | 2.03 |
| Hatcher | Heavy | F | 42.44 | 10.06 | 3.27 | 39.41 | 9.14 | 2.30 |
| | | M | 41.35 | 9.96 | 1.82 | 39.35 | 8.67 | 1.91 |
| | Light | F | 41.94 | 9.97 | 3.13 | 39.14 | 8.47 | 1.36 |
| | | M | 42.74 | 9.47 | 2.11 | 40.34 | 8.63 | 1.85 |
| SEM | | | 0.792 | 0.378 | 0.366 | 1.483 | 0.583 | 0.488 |
| House | | | 43.38[a] | 9.74 | 2.14 | 43.04[a] | 8.37 | 2.28 |
| Hatcher | | | 42.12[b] | 9.86 | 2.58 | 39.56[b] | 8.73 | 1.86 |
| SEM | | | 0.397 | 0.189 | 0.183 | 0.734 | 0.292 | 0.245 |
| Heavy | | | 42.65 | 9.95 | 2.21 | 41.91 | 8.31 | 2.30 |
| Light | | | 42.85 | 9.66 | 2.51 | 40.69 | 8.79 | 1.83 |
| SEM | | | 0.397 | 0.189 | 0.183 | 0.734 | 0.292 | 0.245 |
| Female | | | 42.46 | 9.89 | 2.84[a] | 41.37 | 8.57 | 2.17 |
| Male | | | 43.03 | 9.72 | 1.88[b] | 41.24 | 8.52 | 1.97 |
| SEM | | | 0.397 | 0.189 | 0.183 | 0.734 | 0.292 | 0.245 |
| P-value | | | | | | | | |
| HS | | | 0.026 | 0.652 | 0.089 | 0.001 | 0.387 | 0.225 |
| EW | | | 0.720 | 0.276 | 0.257 | 0.241 | 0.243 | 0.182 |
| G | | | 0.312 | 0.529 | 0.001 | 0.904 | 0.899 | 0.561 |

[a,b] Means with different superscripts differ significantly (P≤0.05). [1]Hatching System: The eggs were hatched in machine or house. [2]Egg Weight: Heavy ≥ 160 g, Light < 160 g [3]Gender: [4]Female; [5]Male

Both domestic (38 breeds) and wild (35 species) male geese are heavier than females, mean body weights are 6.64 and 5.70 kg, and 3.12 and 2.36 kg, respectively (Parés-Casanova 2014). In addition, at slaughter and heavier carcass with less abdominal fat of ganders. However, the ratios of the different carcass parts did not differ between males and females (Fortin et al., 1983). Kırmızıbayrak et al. (2011) reported that pH of breast meat to be lower for males and a* values of breast meat to be lower for female geese. Liu et al. (2011) reported females to have higher amounts of breast meat dry matter, but less protein content than males. As it is known in the common literature, according to our current study results, male geese had higher body weight from the 6th week. However, male geese had higher carcass weights and ratios. Again, as in the literature (Fortin et al., 1983), there was no difference between carcass parts, blood and feather ratio and breast b* value was found to be higher in females, while the ratio of foot and head was found to be higher in males.

## Conclusion

In conclusion, geese hatched from the house system had more BW at the slaughter age compared to machine system geese. In addition, geese produced from heavy eggs showed a higher hot and cold dressed percentages than geese produced from light eggs. It is seen that there is a need for detailed studies on the hatching period and brooding in geese.

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