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# GROWTH PERFORMANCE, CARCASS COMPOSITION AND TENDERNESS OF MEAT IN MALE LAYER-TYPE CHICKENS SLAUGHTERED AT DIFFERENT AGE

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**Abstract**

An experiment with male layer-type chickens was carried out in the Institute of Animal Science-Kostinbrod, aiming to investigate their growth performance and carcass composition, as well as the cooking loss and tenderness of the meat at the age of 5 and 9 weeks. The birds were reared in controlled microclimate, with initial stocking density of 22 birds/$m^2$. After 5 weeks of age, fragmentation of the stocking density was applied and it was diminished to 7 birds/$m^2$. Chickens were slaughtered at 5 and 9 weeks of age, and 10 chickens of each age group were subjected to carcass analysis. The average live weight of the birds at 5 weeks was 329 g, while the 9 weeks old chickens reached 1096 g. In order to attain the weight of the first age of slaughter (5 weeks) the chickens gained 294.03 g with a feed conversion ratio of 2.97, whereas for the whole period the feed conversion ratio was 2.91. The dressing percentage of the 5 weeks old chicks was 51.26%. For the 9 weeks old it was 77.62%. The age affected the yield of the main carcass components and the older birds had higher yield of breast ($P = 0.0035$) and thighs ($P < 0.0001$). The cooking loss for both breast and thigh meat was higher in younger chickens ($P < 0.0001$).

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The tenderness measured as Warner-Bratzler shear force (WBSF) of breast and thigh remained unaffected by the age at slaughter. Its values classified the meat of the male layer-type chickens from this trial as "very tender".

**Key words:** male layer-type chickens, growth performance, carcass, meat cooking loss, tenderness

**Introduction.** The common practice for the 1-day old male layer-type chickens that are hatched is their culling. This poses a problem for the poultry industry since this practice has been sharply criticized for years. Several alternatives for avoiding culling have been proposed and represented in an extensive review [1]. Social concerns have also been taken into account and as a result, rearing this type of birds for meat production met high degree of social acceptance [2]. The main problem with this approach is that raising male layer-type chickens is a longer and less profitable process. The birds have lower weight gain and use more feed to achieve weight suitable for slaughter when compared to the fast-growing broilers [3]. Hence, strategies for improvement of these parameters and avoiding the higher cost for production should be explored. A suitable decision might be the fragmentation of the stocking density. The fragmentation of the stocking density that is applied in this experiment has been modified in the Institute of Animal Science-Kostinbrod. It is based on the practical experience to apply higher stocking density for the birds from meat and layer breeds at earlier age. Consequently, the stocking density is fragmented at a certain age. One advantage of this method is that there is full workload during the first few weeks of the rearing, when the rearing costs are the highest; in addition, the well-known method of selection according to the live weight is applied, thus allowing to select the birds with fastest growth and highest live weight for further rearing, and at the same time eliminate the birds that grow slowly. Another advantage is that more than one slaughter can be carried out within one production cycle, and the meat yield per unit area can be increased. Previous studies [3] showed that the age for applying fragmentation of the stocking density in male layer-type chickens is 5 weeks. Until this age, the male layer-type chickens have good rates of growth and the production costs are affordable. The age of slaughter is of great importance for the composition of the carcass in terms of the deposition of meat in its separate parts. Also, its effect on the meat quality parameters has been considerable. Meat tenderness is a quality trait that is critical for consumers' acceptance [4]. It mostly depends on the fibre size and collagen content in the muscles. Studies on the effect of age in poultry on the meat tenderness have reported contradictory results [5,6], while others also showed that it depended on the genetic strain and rearing system [7,8]. The aim of this study was to investigate the growth performance, carcass composition, and tenderness of meat in male layer-type chickens slaughtered at different ages.

**Material and methods.** ***Experimental birds and housing.*** The trial was carried out in the experimental poultry farm in the Institute of Animal

Science-Kostinbrod, Bulgaria with a total of 800 male layer-type chickens of Lohmann Brown Classic hybrid. The birds were distributed into 5 groups each containing 160 chickens. They were reared conventionally until 9 weeks of age, at initial density of 22 chickens/$m^2$. After 5 weeks of age fragmentation of the stocking density was applied to reach 7 birds /$m^2$. The decrease of the stocking density of the chickens was done through preliminary weighing of each bird and differentiation by the live weight. Thus, the chickens to reach 9 weeks of age remained 1/4 of all the birds initially set for the experiment. For each of the groups the limit weight was individually determined and all the birds with lower weight ($\leq$ 360 g) were slaughtered. The groups of male layer-type chickens were reared in separate pens in deep litter and controlled microclimate. The lighting regime was 3 h light and 3 h dark that repeated during the 24 h cycle. Feeding was ad libitum with standard broiler feed containing maize, wheat, sunflower meal and soybean meal (crude protein 20%, crude fat 4.60%, crude fibre 5.00%, Ca 0.90%, P 0.65%, Lys 1.10%, Met 0.50%, metabolizable energy 3000 kcal/kg). Water was provided through gravity drinkers. During the trial period the live weight (LW) and the feed intake (FI) of the birds were controlled weekly. These indicators were further used to calculate the body weight gain for the controlled period (BWG) and the feed conversion ratio (FCR) of the male layer-type chickens.

***Slaughtering and carcass analysis.*** The chickens were slaughtered at the age of 5 and 9 weeks in a certified poultry abattoir. The birds were stunned, decapitated and bled and then the carcasses were plucked and eviscerated. Feet and edible viscera (heart, liver, gizzard) were removed in order to obtain the ready-to-cook carcass. The carcasses were then chilled and stored at 4 °C for 24 h. On the next day 10 chickens of each age group were subjected to carcass analysis. Each of the carcasses was weighed and cut to neck, breast, thighs, wings and back. Furthermore, the muscles of the breast (m. *Pectoralis profundus et superficiallis*) and thighs of each chicken were separated, weighed and kept for analysis of cooking loss and tenderness.

***Cooking loss and tenderness measurements.*** Cooking losses were measured as described by ECHEGARAY et al. [9]. The breast and thigh meat pieces were weighed, placed into plastic bags, sealed and cooked at 80 °C until internal temperature of the meat reached 70 °C. Then the bags were removed and the meat was left to cool at room temperature for approximately 30 min. The meat pieces were dried to eliminate any water left on the surface and then weighed. The cooking loss was expressed as a percentage using the following equation:

$$\text{Cooking loss} = [(W_1 - W_2)/W_1] \times 100, \%,$$

where $W_1$ is the initial weight of the sample (g),

$W_2$ is the weight after cooking (g).

The tenderness of the meat was measured by WBSF, using Belle texture analyzer. The measurements were done on cooked meat from breast and thigh at the day of carcass analysis and then after 24 h refrigerated storage. Shear force

was evaluated on cores cut from the thickest part of the cooked samples by cutting them perpendicularly to the direction of the fibres [10].

***Statistical evaluation.*** Results are presented as Mean ± SD. The values of the carcass and meat traits from the chickens in both age groups were compared through *t*-test (JMP v.7, SAS Institute Inc. Cary, NC).

**Results and discussion.** ***Growth performance of the male layer-type chickens.*** The average initial live body weight of the 1-day old male layer-type chickens was 34.97 g. At 5 weeks of age the chickens reached 329.00 g and until the end of the experiment (9 weeks) their live weight increased to 1096.01 g (Fig. 1). Until 6 weeks of age the body weight gain increased gradually (Table 1), however on the 7th week of the experiment a slight decrease in this parameter was observed, however, the live body weight of the chickens remained higher. In order to reach the weight of the first age of slaughter (5 weeks) the chickens gained 294.03 with a FCR of 2.97, whereas for the whole period FCR was 2.91. The highest growth rate was observed in the chickens at 2nd and 3rd week (82.56% and 77.37%, respectively). However, until the end of the trial period, a stable decline in the growth of the chickens was registered, with minimal values at 9th week (24.45%). The male layer-type chickens are slow-growing and reach slaughter weight for a much longer period compared to broilers or dual purpose lines. This is due to genetic factors. Whereas the selection in broilers has been directed for meat production only, with fast growing, the layer-type has been developed for egg production and medium body size. Comparison between commercial broilers, dual purpose lines and layer-type chickens all fed broiler diet [2] showed that for a period of 9 weeks, traditional dual purpose lines reached between 1317 g and 1758

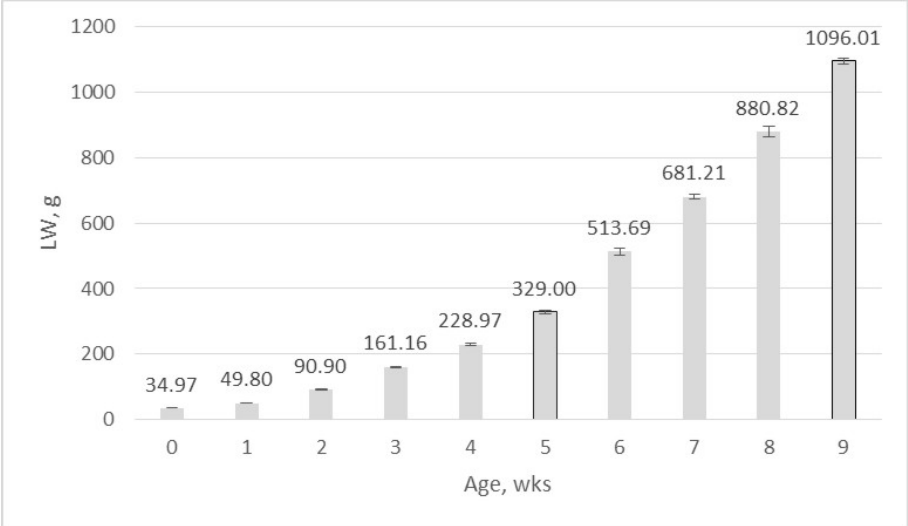


Fig. 1. Live weight of the male layer-type chickens during the trial period

g, slower growing broilers Sasso 51 reached 2423 g, while for the same period the layer-type birds reached 1227 g, that is comparable to our results. The growth performance of the birds, however, might be greatly affected by the housing system and feed. When reared free range, male layer-type chickens reached 1769 g for 90 days, and consumed 3.8 kg feed per kg of weight gain [11]. Similar to our results, it was found that from 1 to 70 days of age the layer-type male chickens consumed 3424 g feed, and used 2.8 kg feed to reach the weight of 1243 g [12].

Table 1

Dynamics of the growth parameters of the male layer-type chickens

| Trait | BWG, g | FI, g/bird | FI cumulative, g/bird | FCR (feed/gain) | Growth rate, % |
|---|---|---|---|---|---|
| 1 wk | 14.83±1.20 | 56.05±0.19 | 56.05±0.20 | 3.78±0.33 | 42.40±3.49 |
| 2 wk | 41.10±0.72 | 70.77±1.03 | 126.82±1.02 | 1.72±0.03 | 82.56±1.14 |
| 3 wk | 70.25±3.27 | 197.76±2.03 | 324.58±2.82 | 2.81±0.13 | 77.37±5.20 |
| 4 wk | 67.81±4.28 | 254.20±1.42 | 578.78±3.01 | 3.75±0.27 | 42.11±3.05 |
| 5 wk | 100.02±3.54 | 393.49±2.29 | 872.27±4.73 | 3.93±0.27 | 43.68±1.09 |
| 6 wk | 184.69±14.77 | 362.32±16.45 | 1335.59±18.57 | 1.97±0.24 | 56.21±5.42 |
| 7 wk | 167.52±5.80 | 468.88±26.22 | 1804.47±43.59 | 2.80±0.12 | 32.64±1.75 |
| 8 wk | 199.61±10.34 | 640.58±34.20 | 2445.05±77.26 | 3.21±0.33 | 29.30±1.46 |
| 9 wk | 215.19±12.94 | 644.34±24.17 | 3089.40±100.73 | 2.99±0.11 | 24.45±1.84 |

At the age of 5 weeks the chickens selected for slaughter had an average body weight 350.79 g, whereas the average slaughter weight at 9 weeks was 1167.63 g. The dressing percentage of the carcasses was 56.21% and 77.62%, respectively, for the age of 5 and 9 weeks, as the latter is comparable to the dressing percentage of fast-growing broilers. As shown in Table 2, the weight of the ready-to-cook carcass of the chickens at 5 weeks of age was 188.88 g while at 9 weeks it increased to 793.70 g. The breast yield differed between the age groups ($P = 0.0035$) showing advantage for the chickens slaughtered at 9 weeks of age (22.08% vs. 23.66%). The same was observed in regard to the percentage of the thighs (30.48% vs. 32.72%) ($P < 0.0001$). It should be mentioned that the yield of the thighs was higher than that of the breast regardless of the age at slaughter (8.7%). Typically, slower-growing birds have higher percentage of thighs than breast as shown by other studies [11, 13, 14]. However, the authors reported lower than our values of breast yield (14.2–15.6% [11], 17.8–18.4% [13]; 14.8–15.7% [14]). For 51-day old male layer type chickens, the breast yield was 8.1% [15]. The high breast yield that we recorded for the male chickens in this experiment was also observed earlier [16] in male layer-type chickens slaughtered when 12 weeks old. Slaughter at different ages was only studied by Lichovníková et al. [11] and contrary to us, no difference between the age groups was reported in regard to the carcass traits. The differences that we observed can be a result of the fragmentation of stocking den-

sity that was applied to the flock. Studies on the stocking density in poultry have confirmed the effect of this parameter on the carcass characteristics and meat deposition in the birds. The experiments have mainly been conducted with broilers and observed different effect of the stocking density on breast and thigh yield depending on the genetic line. Nasr et al. [17] reported increased breast percentage but lower thigh proportion in medium growing broilers at lower stocking density. On the other hand, in fast growing broilers, the authors observed increase in both breast and thigh at lower density. Such results have been previously reported [18]. A more recent study on the stocking density in fast and slow-growing broilers [19], failed to observe any effect of this parameter on the breast and thigh yields, as well as the other parts of the carcass in both strains. Studies on the effect of stocking density in male layer-type chickens are rather scarce. Petkov [16] reported higher yield of breast meat in male layer-type chickens reared at lower density after 5 weeks of age. The author also observed higher live weight in the birds after stocking density fragmentation reached at earlier age. This means that the density fragmentation method is quite useful when rearing male layer-type chickens, since it allows slaughter at earlier age and avoiding the higher production costs for this type of birds for a longer period. The rest of the parts of the carcass had lower proportion ($P < 0.0001$) in the older chickens. The proportion of the muscles of breast and thighs remained higher in the chickens slaughtered at 9 weeks of age.

Table 2

Carcass analysis of the male layer-type chickens slaughtered at 5 and 9 weeks of age

| Trait | 5 weeks | 9 weeks | Sig. |
|---|---|---|---|
| Ready-to-cook carcass, g | 188.88±19.69 | 793.70±21.64 | < 0.0001 |
| Breast, % | 22.08±1.27 | 23.66±0.61 | 0.0035 |
| Thighs, % | 30.48±0.97 | 32.72±0.92 | < 0.0001 |
| Wings, % | 15.70±0.67 | 13.70±0.42 | < 0.0001 |
| Back, % | 23.68±0.80 | 21.72±0.58 | < 0.0001 |
| Neck, % | 7.58±0.85 | 3.88±0.23 | < 0.0001 |
| Breast muscle, % | 11.73±0.97 | 15.24±0.54 | < 0.0001 |
| Thigh muscle, % | 19.36±0.89 | 21.25±0.87 | 0.0002 |

Age affected significantly ($P < 0.0001$) the cooking losses of meat from both cuts (Table 3). The male layer-type chickens slaughtered 5 weeks old had higher percentage of cooking loss when compared to older chickens in breast (36.99% vs. 30.24%), and thighs (39.20% vs. 29.67%). The values of cooking loss that we measured were higher than reported for male chickens from laying breeds. Values of 21.07–24.93% for breast and 24.04–25.78% for thigh meat, respectively, in 16 weeks old Barred Plymouth Rock and Shanghai chickens were measured [14]. Furthermore, Mueller et al. [2] reported cooking loss of 9.4% in breast of Lohmann

Table 3

Cooking loss and tenderness of the breast and thigh meat of male layer-type chickens at the age of 5 and 9 weeks

| Trait | 5 weeks | 9 weeks | Sig. |
|---|---|---|---|
| Breast | | | |
| Cooking loss, % | 36.99±1.41 | 30.24±1.92 | $< 0.0001$ |
| WBSF, kg | 2.45±0.81 | 2.60±0.72 | 0.6567 |
| WBSF 24 h, kg | 2.48±0.93 | 2.16±0.51 | 0.3509 |
| Thigh | | | |
| Cooking loss, % | 39.20±2.58 | 29.67±1.24 | $< 0.0001$ |
| WBSF, kg | 1.95±0.75 | 1.86±0.31* | 0.7190 |
| WBSF 24 h, kg | 1.99±0.62 | 2.30±0.48 | 0.2278 |

*Significant difference between the values measured before and after refrigerated storage ($P = 0.02$)

Brown Plus slaughtered at 9 weeks. However, this is not comparable to our results since the experiment has included frozen storage of the meat. Połtowicz and Doktor [10] have observed higher cooking loss in breast and thigh in slower growing chickens slaughtered at three ages. In addition, they found significantly higher cooking losses in thigh meat of younger birds which is in agreement with our results. No difference between the age groups was found in regard to the shear force values, which could be considered a positive result for the tenderness of the meat in this type of birds. Jaturasitha et al. [14] observed considerably higher shear force for the male layer-type chickens for both breast and thigh meat. Also, Połtowicz and Doktor [10] found that shear force raised significantly in slow-growing broilers at the age of 84 days, when compared to 56 and 70 days old. Such results were also reported for breast and thigh meat of local chicken breeds at the age of 20, 24 and 29 weeks [5]. On the other hand, Li et al. [6], reported no increase in the shear force in native chickens between 60 and 90 days of age. At the age 120 days, the authors reported higher shear force, which remained unchanged until 180 days. At 9 weeks of age, there was significant difference in the shear force values of the thigh samples before and after storage ($P = 0.02$), showing increased firmness in the stored samples. Nevertheless, the values of the shear force that we measured in this experiment classify the meat as "very tender" ($< 3.62$ kg) [20].

**Conclusions.** The present study revealed some characteristics of the male layer-type chickens associated with their further use for meat production. The experiment showed that this type of birds can be successfully reared to a suitable slaughter weight after fragmentation of the stocking density after 5 weeks of age. This method applied to the male chickens allowed slaughter at earlier age with dressing percentage comparable to commercial broilers. The age affected posi-

tively the yield of the meat from breast and thigh cuts. The tenderness of the breast and thigh meat remained unaffected by the age and the values of the shear force showed that the meat from both 5 and 9 weeks old birds was "very tender".

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