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Meat Quality of Male Layer-Type Chickens Slaughtered at Different Ages

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Abstract: An experiment with male layer-type chickens of the Lohmann Brown Classic breed was carried out at the Institute of Animal Science-Kostinbrod, Bulgaria, aiming to investigate the effect of age at slaughter on the meat quality. The birds were reared in a controlled microclimate, with an initial stocking density of 22 birds/m^2. At five weeks of age, fragmentation of the stocking density was applied, decreasing the number to seven birds/m^2. Chickens were slaughtered at five and nine weeks of age at an average live weight of 329 g and 1096 g, respectively. After slaughter, 10 chickens from each age group were subjected to analysis to determine the quality of breast and thigh meat. The results of the study showed that the age affected the meat quality parameters of the male layer-type chickens and its effect differed between the breast and thigh. The chickens slaughtered at nine weeks of age displayed a lower pH but darker meat color ($p < 0.001$) than those slaughtered at five weeks. Furthermore, the older birds showed a significant decrease in the intramuscular fat content in thigh meat ($p < 0.01$) and a tendency for diminishing in breast meat. This decrease corresponded to the lower percentage of monounsaturated fatty acids (MUFA) in the meat of the nine-week-old chickens ($p < 0.01$). On the other hand, the meat of the older chickens displayed a higher content ($p < 0.01$) of polyunsaturated fatty acids (PUFA), especially n-6, leading to a considerably higher n-6/n-3 ratio.

Keywords: male layer-type chickens; age; meat quality; fatty acids

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1. Introduction

The increasing demands of consumers regarding the quality of poultry meat produced globally require intensive selection of broilers for rapid growth and low feed intake. The selection according to these indicators has an economic effect but leads to negative changes in the quality of the harvested meat [1]. According to Baldi et al. [2] the major meat quality concerns are associated with abnormalities in breast meat, such as wooden breast, white striping, and spaghetti meat, that affect alone or in combination the meat of fast-growing broilers. These growth-related abnormalities not only impair the appearance of the meat, but also have a detrimental effect on the technological qualities [3]. Hence, the interest in the meat of slow-growing chickens has considerably increased. It has gradually grown in popularity in the market as a product with excellent taste and dietary values [4,5], and in some EU countries its production has increased significantly in the recent years [6].

Previous studies [7,8] found that the growth rate and the feed conversion of male layer-type chickens meet the minimum criteria for slow-growing chickens; even in the first four weeks of rearing their feed intake resembles slow-growing broilers. This reveals possibilities for their utilization and the conversion of a waste product from the production of female layer chickens into a secondary product for an innovative, independent, and economically sustainable niche for producing high-quality poultry meat products. After hatching, the male layer-type chickens are often used in the manufacturing of pet foods or are culled due to their low live weight. This poses both animal welfare and ethical issues [9] provoking sharp criticism in society [10] and made it necessary to explore other ways to use layer-type cockerels. Three methods for utilization have emerged to avoid culling of this type of chicken: in ovo sex determination, use of dual-purpose breeds, and rearing male cockerels for meat. In Bulgaria, research on this topic commenced in 2010; however, studies on the meat quality of these birds are scarce. Our previous studies with male layer-type chickens showed that despite the certain disadvantages of the performance traits of these birds compared to the fast-growing broilers, they also have more positive traits, such as low deposition of abdominal fat and lower intramuscular and subcutaneous fat [8]. We found that the meat of layer-type cockerels slaughtered at 12 weeks of age is not inferior in quality to that obtained from slow-growing chickens; on the contrary, they have a higher protein content, a higher WHC, and lower intramuscular fat [8]. The quality of meat is determined by various factors, among which is the age at slaughter [11]. Dal Bosco et al. [12] compared chickens from different genotypes slaughtered at different ages and showed that the meat of younger chickens was more tender, while the older birds had lighter meat. Li et al. [13] confirmed higher tenderness of the meat in younger chickens and found improved water-holding capacity with increasing age. Age can affect the nutritional profile and healthy value of the meat, which is also determined by its fatty acid profile. In slow-growing chickens slaughtered at different ages [14], a significantly higher content of saturated fatty acids in thigh meat and a higher content of polyunsaturated fatty acids in both the breast and thighs of older chicks was reported. Furthermore, the content of cholesterol in meat was significantly lower in chickens slaughtered at an older age. Determining the optimal age for slaughtering animals and poultry is crucial to obtain the best characteristics in the carcass and meat and the highest nutritional and health values [13,15–17].

With a current scarcity of scientific information on the male layer-type chickens, this research was conducted to provide a better insight into the differences in the meat quality of this type of chickens slaughtered at different age. The data obtained in this study will complement the current scientific knowledge on slow-growing chickens and can also be used as a basis for further research on the processing quality of this type of meat.

2. Materials and Methods

2.1. Ethical Procedure

The experimental protocol used in this study, including the animal management and housing, was designed in compliance with the guidelines of the European and Bulgarian legislation regarding the protection of animals used for experimental and other scientific purposes [18]. The protocol was based on the permit for use of animals in experiments No. 227 of the Bulgarian Food Safety Agency (Statement No. 193 of the Bulgarian Animal Ethics Committee, prot.No.18/02.07.2020).

2.2. Experimental Birds and Housing

The trial involved 800 male layer-type chickens of the Lohmann Brown Classic breed hybrid and was carried out in the experimental poultry farm at the Institute of Animal Science-Kostinbrod, Bulgaria. The 1-day-old chickens were supplied by Bulagro 97 AD. The birds were housed in 5 pens each containing 160 chickens and were reared conventionally until slaughter. The initial stocking density was 22 chickens/m^2 and at 5 weeks of age, this was decreased to 7 birds/m^2. The fragmentation of the stocking density of the chickens was undertaken through preliminary weighing of each chicken and differentiation by the live weight. Thus, all the male layer-type chickens with a final body weight of $\leq$360 g were slaughtered at 5 weeks of age, and the remaining chickens were reared until 9 weeks old. The chickens were reared in deep litter and a controlled microclimate. The lighting regime was 3 h light and 3 h dark which repeated during the 24 h cycle. Feeding was ad libitum with standard broiler feed (Tables 1 and 2) according to the instructions for Ross

308 broilers [19]. Water was provided through gravity drinkers. During the trial period, the live weight of the birds was controlled weekly.

Table 1. Composition of the diet of the male layer-type chickens.

Component	Content, %
Maize	47
Wheat	15.12
Sunflower meal	8
Soybean meal	24.3
Sunflower oil	2
Limestone	1.26
Monocalcium phosphate	1.25
Salt	0.19
Met	0.2
Lys	0.195
Vitamin premix [1]	0.2
Mineral premix [1]	0.2
Choline chloride	0.085
Calculated composition	
Crude protein, %	20.00
Fat, %	4.60
Ash, %	5.70
Crude fibers	5.50
Ca	0.90
P	0.65
Metabolizable energy, kcal/kg	3000

[1] Vitamin and mineral premix provided the following per kg of diet: Fe,185 mg; Cu, 25 mg; Zn, 120 mg; Mn, 145 mg; I, 1.70 mg; Se, 0.45, vit. A 10500 IU; vit. D, 3750 IU; vit. E, 45 mg; BHT, 0.10 mg; endo-1,4 beta-xylanase 1500EPU.

Table 2. Fatty acid composition of the feed.

Fatty Acid	C14:0	C16:0	C16:1	C18:0	C18:1 n-9	C18:2 n-6	C18:3 n-3	C20:0
%	0.33	8.89	0.37	2.77	30.74	55.31	1.33	0.26

2.3. Slaughtering Procedure and Sampling

The chickens were slaughtered at 5 and 9 weeks of age in a commercial poultry abattoir at an average live weight of 329 g and 1096 g, respectively. The birds were stunned, decapitated, and bled. The carcasses were then 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. After 24 h of chilling, 10 chickens from each age group were randomly selected for meat quality analysis. The breast (pectoralis profundus et superficialis) and thighs of each carcass were collected, skinned, and deboned. One part of the samples was immediately used for analysis of meat technological quality while the other was vacuum-packed and stored frozen for further analysis of the proximate composition.

2.4. Analysis of the Meat Quality

2.4.1. Measurement of pH and Color

Muscle pH and color were measured at the time of deboning of the breast and thigh cuts. The pH measurements were undertaken using a portable pH meter equipped with a glass electrode. Calibration prior to use at pH 4.0 and 7.0 was performed. The surface color of the breast and thigh muscles was measured by Croma meter CR-410 (Konica Minolta Inc., Osaka, Japan) using CIE values expressed as lightness (L*), redness (a*), and yellowness (b*). A measuring area of 50 mm, illuminant D65, and 2° standard observer were used. The instrument was calibrated using a standard white plate. The measurements of the pH and color were undertaken at 3 locations in the muscles and the results were averaged.

2.4.2. Determination of Water Holding Capacity (WHC)

Water holding capacity measured as free water content (%) was determined according to the filter press method as described by Honikel and Hamm [20].

2.4.3. Texture Analysis

The tenderness of the meat was measured by Warner–Bratzler shear force (WBSF) using a Belle texture analyzer (Agrosta, Serqueux, France). The measurements were undertaken on cooked meat from breast and thigh at the day of carcass analysis. The breast and thigh meat pieces were weighed, placed into plastic bags, sealed, and cooked in a water bath at 80 °C until the internal temperature of the meat reached 70 °C. The bags were then 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. Shear force was evaluated on cores cut from the thickest part of the cooked samples by cutting them perpendicularly to the direction of the fibers [21].

2.4.4. Proximate Analysis

The content of moisture, protein, fat, and ash in the breast and thigh meat was assessed according to the methods of AOAC [22].

2.5. Fatty Acid Profile

The fatty acid composition of the feed and meat was determined according to the method of Bligh and Dyer [23] with slight modifications [24]. Lipids were extracted from 10 g of the muscle/feed sample and homogenized using a HG-15D homogenizer (Witeg Labortechnik GmbH, Wertheim, Germany) with 10 mL of chloroform and 20 mL of methanol for 30 s. Following this, 10 mL of chloroform and 10 mL of NaCl (1% in distilled water) were added to the mixture and homogenized for 30 s. The samples were centrifuged (4000 rpm for 10 min) and finally the chloroform layer was evaporated. The fatty acids were trans esterified following the procedure described by Domínguez et al. [25] with some modifications: 20 mg of extracted fat dissolved in 1 mL of toluene was mixed with 2 mL of a sodium methoxide (0.5 N) solution, vortexed for 10 s, and allowed to stand for 15 min at room temperature. Then, 4 mL of a $H_2\,SO_4$ solution (10% of $H_2\,SO_4$ in methanol) was added, vortexed for 10 s, and left for 5 min before adding 2 mL of saturated sodium bicarbonate solution. Fatty acid methyl esters were extracted as 1 mL of hexane was added to the samples, vortexed for 10 s, and the organic phase was transferred to an appropriate GC vial. Separation and quantification of FAMEs were carried out using a gas chromatograph (CSi 200 series, Cambridge Scientific Instruments Ltd., Ely, UK) equipped with a capillary column (DM-2330:30 m × 0.25 mm × 0.20µm) and hydrogen as a carrier gas. The oven temperature was first set to 160 °C for 0.2 min, then raised to 220 °C at a rate of 5 °C/min and then held for 5 min. The temperatures of the detector and injector were 230 °C. Methyl esters were identified through comparison of the retention times of the standards. Fatty acids are presented as percentages of the total amount of the methyl esters (FAME) identified. The amount of each fatty acid was used to calculate the atherogenic (AI) and thrombogenic (TI) indices [26]:

$$AI = (4 \times C14{:}0 + C16{:}0)/[MUFA + \Sigma(n-6) + \Sigma(n-3)];$$
$$TI = (C14{:}0 + C16{:}0 + C18{:}0)/[0.5 \times MUFA + 0.5 \times (n-6) + 3 \times (n-3) + (n-3)/(n-6)]$$

2.6. Statistical Evaluation

Results are presented as mean ± SD. Comparisons between the 2 age groups in regard to the meat quality traits and the fatty acid profiles were performed through *t*-test (JMP v.7, SAS Institute Inc. Cary, NC, USA).

3. Results

3.1. Effect of Age on the Technological Quality of Meat

The pH values were significantly lower in the breast ($p < 0.05$) and thighs ($p < 0.001$) of the older chickens (Table 3). In breast the pH ranged from 5.67–5.73, while for the thighs this trait varied from 6.08 to 6.25.

Table 3. Quality traits of the breast and thigh meat.

Item	5 Weeks	9 Weeks	Sig.
Breast			
pH 24	5.73 ± 0.05	5.67 ± 0.074	*
L*	59.46 ± 2.65	54.14 ± 1.27	***
a*	16.04 ± 1.18	14.16 ± 1.18	**
b*	11.22 ± 1.23	8.76± 1.28	***
WHC, %	39.87 ± 2.06	35.58± 2.45	***
WBSF, kg	2.45 ± 0.81	2.60 ± 0.72	ns
Thigh			
pH 24	6.25± 0.09	6.08 ± 0.11	***
L*	52.47± 2.89	44.72 ± 1.47	***
a*	20.38 ± 1.30	19.22 ± 0.68	ns
b*	8.87 ± 0.61	6.79 ± 0.46	***
WHC, %	33.08 ± 3.20	33.93 ± 1.22	ns
WBSF, kg	1.95 ± 0.75	1.86 ± 0.31	ns

WHC: Water holding capacity; WBSF: Warner–Bratzler shear force. Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$, ns—non-significant.

The color parameters of breast and thigh meat differed between the chickens slaughtered at five and nine weeks of age. The older birds had darker meat with lower L* ($p <$ 0.001) and b* values ($p < 0.001$). On the other hand, the redness was significantly higher in the breast of the chickens slaughtered at five weeks of age ($p < 0.01$) and tended to be higher in the thighs of the younger birds but without significant difference.

The water holding capacity (Table 3) as expressed by lower percentage of free water was better in the breast of the chickens that were slaughtered at nine weeks of age ($p <$ 0.001), while no such difference was observed regarding this trait in the thigh meat. No difference between the age groups was found in regard to the shear force values.

3.2. Proximate Composition

Difference between the age groups regarding the proximate composition was observed in thighs (Table 4). The intramuscular fat content decreased significantly in the older cockerels (2.72% vs. 3.80%, respectively, for the nine- and five-week-old male layer-type chickens, $p < 0.01$). The chickens slaughtered at nine weeks old also displayed higher ash ($p < 0.001$) and moisture ($p < 0.05$) contents.

Table 4. Proximate composition of the breast and thigh meat.

Item	5 Weeks	9 Weeks	Sig.
Breast			
Protein, %	21.10 ± 0.85	21.65 ± 0.66	ns
Intramuscular fat, %	0.54 ± 0.30	0.41 ± 0.17	ns
Moisture, %	75.40± 0.73	75.748 ± 0.61	ns
Ash, %	0.96 ± 0.06	0.99 ± 0.05	ns
Thigh			
Protein, %	17.46 ± 0.65	17.56 ± 0.61	ns
Intramuscular fat, %	3.80 ± 0.75	2.72 ± 0.57	**
Moisture, %	75.95 ± 1.01	76.81 ± 0.33	*
Ash, %	0.87 ± 0.06	0.96 ± 0.034	***

Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$, ns—non-significant.

3.3. Fatty Acid Composition

The fatty acid composition of the meat of the male layer-type chickens differed between the two groups (Table 5).

Table 5. Fatty acid (% FAME) profile of the breast and thigh meat.

Fatty Acid	5 Weeks	9 Weeks	Sig.
Breast			
C14:0	0.61 ± 0.51	0.47 ± 0.10	ns
C14:1	0.10 ± 0.07	0.09 ± 0.08	ns
C15:0	0.26 ± 0.31	0.16 ± 0.04	ns
C16:0	20.43 ± 0.51	20.69 ± 1.18	ns
C16:1n-7	3.34 ± 0.95	2.10 ± 0.86	**
C17:0	0.15 ± 0.07	0.08 ± 0.02	*
C17:1	0.23 ± 0.14	0.63 ± 0.51	*
C18:0	8.84 ± 0.99	9.89 ± 0.99	*
C18:1n-9	30.99 ± 3.98	26.75 ± 2.53	**
C18:2n-6	23.38 ± 1.99	23.20 ± 1.68	ns
C18:3n-6	0.12 ± 0.01	0.12 ± 0.02	ns
C18:3n-3	0.69 ± 0.17	0.41 ± 0.13	***
C20:0	0.29 ± 0.08	0.26 ± 0.08	ns
C20:2n-6	0.36 ± 0.07	0.48 ± 0.17	ns
C20:3n-6	0.93 ± 0.21	1.00 ± 0.27	ns
C20:4n-6	6.25 ± 1.89	9.36 ± 1.88	**
C20:5n-3	0.19 ± 0.04	0.11 ± 0.04	***
C22:4n-6	1.46 ± 0.42	2.49 ± 0.55	***
C22:5n-3	0.67 ± 0.16	0.85 ± 0.19	*
C22:6n-3	0.71 ± 0.26	0.86 ± 0.21	ns
Thigh			
C14:0	0.43 ± 0.15	0.54 ± 0.06	*
C14:1	0.10 ± 0.05	0.16 ± 0.04	*
C15:0	0.10 ± 0.03	0.17 ± 0.04	***
C16:0	19.65 ± 1.27	19.22 ± 1.55	ns
C16:1n-7	4.39 ± 1.04	4.02 ± 1.18	ns
C17:0	0.12 ± 0.03	0.19 ± 0.03	***
C17:1	0.18 ± 0.07	0.21 ± 0.06	ns
C18:0	8.55 ± 1.01	8.43 ± 0.89	ns
C18:1n-9	36.92 ± 3.42	32.18 ± 1.88	***
C18:2n-6	23.44 ± 2.41	26.90 ± 2.21	**
C18:3n-6	0.14 ± 0.02	0.18 ± 0.02	***
C18:3n-3	0.93 ± 0.03	0.72 ± 0.08	***
C20:0	0.37 ± 0.09	0.31 ± 0.12	ns
C20:2n-6	0.19 ± 0.08	0.30 ± 0.11	*

Table 5. *Cont.*

Fatty Acid	5 Weeks	9 Weeks	Sig.
C20:3n-6	0.32 ± 0.06	0.36 ± 0.07	ns
C20:4n-6	2.84 ± 0.51	4.33 ± 0.90	***
C20:5n-3	0.06 ± 0.02	0.02 ± 0.01	**
C22:4n-6	0.68 ± 0.13	1.16 ± 0.35	***
C22:5n-3	0.32 ± 0.08	0.31 ± 0.07	ns
C22:6n-3	0.27 ± 0.08	0.29 ± 0.07	ns

Significance: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$, ns—non-significant.

The changes in the percentage of the individual fatty acids affected by age did not follow the same pattern in breast and thigh. The breast meat showed significantly higher contents of C17:1, C18:0, C20:4n-6, C22:4n-6, and C22:5n-3 in the older chickens. On the other hand, the breast meat of these birds displayed a lower percentage of C16:1n-7, C17:0, C18:1n-9, C18:3n-3, and C20:5n-3. More fatty acids were affected by the age in the thigh meat. The male layer-type chickens, slaughtered at nine weeks of age had a significantly higher content of C14:0, C14:1, C15:0, C17:0, C18:2n-6, C18:3n-6, C20:2n-6, C20:4n-6, and C22:4n-6, while the percentages of C18:1n-9, C18:3n-3, and C20:5n-3 were lower. In regard to the total amounts of the fatty acids, generally, the meat from older chickens had lower MUFA ($p < 0.01$) and higher PUFA ($p < 0.01$), while the total percentage of SFA remained unaffected (Table 6). The values of n-6/n-3 ratio increased with age in both breast and thighs, while the P/S ratio was higher only in the thigh meat of the older chickens. The values of AI and TI were similar in both age groups.

Table 6. Lipid nutritional indices of the breast and thigh meat.

Item	5 Weeks	9 Weeks	Sig.
Breast			
SFA	30.58 ± 1.48	31.55 ± 1.58	ns
MUFA	34.66 ± 4.74	29.57 ± 2.45	**
PUFA	34.76 ± 4.26	38.88 ± 2.30	**
n-6/n-3	14.38 ± 1.09	16.30 ± 2.13	**
P/S	1.13 ± 0.13	1.23 ± 0.11	ns
AI	0.33 ± 0.03	0.33 ± 0.03	ns
TI	0.74 ± 0.04	0.78 ± 0.04	ns
Thigh			
SFA	29.22 ± 1.31	28.86 ± 1.11	ns
MUFA	41.59 ± 3.61	36.57 ± 2.85	**
PUFA	29.19 ± 3.01	34.57 ± 33.43	**
n-6/n-3	17.47 ± 1.72	24.79 ± 2.25	***
P/S	1.00 ± 0.10	1.20 ± 0.11	**
AI	0.30 ± 0.03	0.30 ± 0.02	ns
TI	0.73 ± 0.04	0.72 ± 0.04	ns

SFA: Saturated fatty acids; MUFA: monounsaturated fatty acids; PUFA: polyunsaturated fatty acids; P/S: poly-/saturated fatty acids; AI: atherogenic index; TI: thrombogenic index. Significance: ** $p < 0.01$; *** $p < 0.001$, ns—non-significant.

4. Discussion

Meat quality, including poultry meat, is very complex and might be affected by many factors [27]. This study illustrates the effect of age on the physical traits, chemical composition, and fatty acid profile with related lipid nutritional indices in the meat of male layer-type chickens. One of the physical traits that is known to be crucial for meat technological quality and safety is the ultimate pH [28]. The rapid pH decline postmortem and low values of pH are associated with PSE-like conditions, poor WHC, and functionality [29]. On the other hand, higher pH values can decrease the shelf life of the meat making it more susceptible to bacterial spoilage [30]. The pH also depends on the muscle type, which could explain the difference in this trait between the breast and the thigh meat. The values of pH that were observed in this study are within the normal range according to the limits set by Zhang and Barbut [31] for the five-week-old chickens. The effect of age on pH was reported in broilers [32,33] and also in spent hens [34]. In line with our results, these studies showed lower pH in the birds slaughtered at an older age. However, in a previous experiment [35], significantly increased pH values were reported in the breast and thigh meat of male layer-type chickens slaughtered at 12 weeks of age when compared to 5-week-old chicks. Contrary to us, Lichovníková et al. [36] did not find a difference in pH in the breast meat of male layer-type chickens, reporting values similar to ours (5.73–5.77); however, they were significantly higher than the pH in broiler meat.

Water holding capacity is very important for meat functional properties and determines the quality for further meat processing [37]. It was demonstrated that both pH and WHC correlate with meat color [38,39]. The results of the trial revealed a darker color of the breast and thigh meat in the older chickens, despite the lower pH in this age group, which is usually correlated with a lighter meat color [38]. On the other hand, the higher WHC in the older birds in breast meat corresponds to the lower L*, since the lower percentage of free water decreases the light reflected from meat surface [40]. In addition to the lower L* values determined in the male chickens slaughtered at the age of nine weeks, this age group also showed lower yellowness (b*) in the breast and thigh meat. This is in line with the results in broilers [41] and in Da-Heng meat-type chickens [13].

Usually, the ageing of animals is associated with lower tenderness of meat, mainly due to a decrease in the collagen solubility [42]. In poultry, the results of the effect of age on the tenderness of meat are contradictory. In heavy lines of broilers aged 35–63d there was no effect of age at slaughter on the shear force [41]. Recently, it was found that the tenderness of breast and thigh meat of broilers slaughtered at 28 days of age was significantly higher when compared to those at 30, 32, and 34 days of age [43]. However, the authors did not observe differences between age 30 and 34 days. In slow growing chickens, Wang et al. [44], found a significant increase in the shear force of breast and thigh meat between age 63 d and 105 d. On the other hand, they found no effect of age on the shear force in native chickens reared under a semi-free-range system [45]. The values of the shear force reported in our study are similar to those of Choo et al. [46], when comparing egg-type males, white mini broilers, and commercial broilers (Ross 308). As shown in Table 3, the shear force values were higher in the breast, which can be attributed to the higher content of intramuscular fat [47]. Nevertheless, the values of the shear force that were measured in this experiment classify the meat as "very tender" (<3.62 kg) [48].

The proximate composition differs between the groups only for thigh meat. While the intramuscular fat decreased in the older chickens, the moisture and the ash content increased in these birds compared to the five-week-old birds. Decreased intramuscular fat and increased moisture with aging in chickens have been reported in previous studies with slow-growing [14] and male layer-type chickens [35]; however, results on the effect of the slaughtering age on this parameter in poultry have been rather inconsistent. Dal Bosco et al. [12] observed increased lipid content at an older age in the breast meat of various commercial chicken genotypes reared organically and little to no effect on the moisture. When comparing dual-purpose chickens with layer hybrids, Mueller et al. [49] observed decreased intramuscular fat in Lohmann Brown chickens with prolonged age, but not in the other studied hybrids. The intramuscular fat and its composition are important for organoleptic characteristics but also in the health value of meat and meat products [50]. In the present study, despite the different number of individual fatty acids affected by age in breast and thigh meat, in both meat cuts the MUFA was lower in the older birds. This was determined mostly by the decreased percentage of C18:1n-9 in the breast and thigh, and also corresponds with the decreased intramuscular fat in the meat, particularly in thighs. In a previous study on two slow-growing lines slaughtered at 9 and 18 weeks, a similar decrease in MUFA in the chickens slaughtered at an older age was observed [51]. An extensive review [52] has well outlined the useful properties of C18:1n-9 for immunomodulation, treatment, and prevention of cardiovascular and autoimmune diseases, metabolic disorders, skin injuries, and even certain types of cancer. Hence, the decrease in the percentage of C18:1n-9 and MUFA can be a disadvantage for the male layer-type chickens slaughtered at the age of nine weeks, compared to those slaughtered at five weeks old.

On the other hand, this was compensated by the lack of changes in the SFA but a significant increase in the PUFA. It should be noted that the increase in PUFA is mainly at the expense of n-6 PUFA. The major n-6 fatty acid in the poultry meat is C18:2n-6. A significant increase in this fatty acid was found in the thigh meat of the nine-week-old chickens. Since it is essential and derived exclusively from feed, its increase in the meat of older chickens might be explained by the higher feed consumption at this age compared to those at five weeks old [48]. The content of C18:2n-6 in the feed as presented in Table 2 is 55.31%. The increase in this fatty acid was also accompanied by increase in C20:4n-6, both in breast and thigh of the older chickens. In a recent study [53], it was recommended that for normal physiological function, the body requirement for optimal n-6/n-3 ratio is approximately 1–2:1. In this study, the n-6/n-3 ratio is much higher. This indicates a certain imbalance of the fatty acid profile of the male layer-type chickens in regard to PUFA that can be improved through feeding strategies or housing systems with access to pasture [54]. Meat has often been implicated in imbalanced fatty acid intake by consumers due to some meats naturally having a low PUFA to SFA ratio (P/S). Thus a P/S ratio of no less than 0.1 is recommended [55]. In the current study, in the older chickens the P/S ratio was higher than the set limit, ranging from 1.13–1.23 in breast muscle versus 1.00 to 1.20 in thighs.

5. Conclusions

The results of the study showed a significant effect of age in meat quality parameters of male layer-type chickens that was different in the different meat portions (breast and thigh). Generally, the chickens slaughtered at nine weeks of age displayed a lower pH and darker color. In regard to the nutrient components, older age was associated with a significant decrease in intramuscular fat in thighs and tended to diminish in breast meat. Its reduced content corresponded to the lower MUFA in the nine-week-old layer-type cockerels. On the other hand, the meat of older chickens was richer in PUFA, especially n-6, significantly increasing the n-6/n-3 ratio. As a whole, the meat of nine-week-old male layer-type chickens showed certain disadvantages in regard to the fatty acid profile which opens the possibilities for further studies on different feeding strategies or housing systems to improve this trait.

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