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ORIGINAL PAPER

The effect of aviary housing system on the quality of meat from male pheasants (*Phasianus colchicus*)*

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Abstract

The aim of this study was to evaluate the effect of two aviary housing systems on the chemical composition, fatty acid profile, physicochemical and sensory properties of the breast muscle (*Pectoralis major, PM*) of male pheasants (*Phasianus colchicus*). Birds were raised on a farm in a normal production cycle. At six weeks of age, pheasants were provided with access to big aviaries (control group, C). A total of 32 males and 224 females (experimental group, E) were randomly selected from among six-week-old birds, and were transferred to 32 small (20 m^2) adjacent aviaries (1 male and 7 females per aviary). Pheasants in both groups were fed identical diets, but in group C, aviaries were planted with cultivated crops that constituted an additional feed source for birds. Randomly selected, 25-week-old males from C (n=8) and E (n=8) group were slaughtered. The muscles of group E pheasants had higher (p=0.031) manganese (Mn) content. The muscles of group C birds were characterized by a higher content of intramuscular fat (IMF, p=0.042), collagen (p=0.009), and copper (p=0.033), and higher aroma intensity (p = 0.048). They also had a tendency (p>0.05) to lower proportion of saturated fatty acids (SFAs; by 4.16 p.p.), higher proportions of monounsaturated fatty acids and polyunsaturated fatty acids (MUFAs and PUFAs; by 1.64 and 2.51 p.p., respectively), higher nutritional quality of IMF, and scored higher for aroma desirability, taste, and tenderness. Minor differences in the properties of the *PM* muscle, observed between the compared groups, could result from the availability of plant-based feed in large aviaries, and its absence in small aviaries.

Keywords: pheasant, aviary housing system, meat quality

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INTRODUCTION

The diet of many contemporary consumers is rich in meat and meat products despite suggestions that meat consumption should be reduced for health-related, environmental and ethical reasons (Kemper et al. 2023). Global meat consumption continues to rise and is projected to reach 43.7 kg per capita per year, compared with 42.4 kg in 2021 (OECD/FAO 2021). Meat is popular because of its high nutritional value and attractive sensory attributes of meat dishes (Halagarda, Wójciak 2022). It should be stressed that the popularity of different meat types varies, and poultry is the most widely consumed meat (14.7 kg per capita in 2018, 43%) – Whitton et al. (2021).

Similarly to other foods, meat and meat products are supposed to not only satisfy hunger but also be a source of pleasure and enjoyment; they should be safe and nutritious, and deliver health benefits due to their functional properties, thus positively influencing the quality of consumers' lives. In addition, some consumers search for unique and unusual foods in terms of their origin and attributes. Therefore, "niche" and alternative products can also be found on the market, including game meat, i.e. the flesh of wild animals (Niewiadomska et al. 2020) that are hunted or raised on farms (Soriano, Sánchez-García 2021). The latter group includes game bird species such as pheasants (*Phasianus colchicus*) – Gálik et al. (2023).

Pheasant farming is popular in Europe and the USA, and birds raised in captivity are released onto hunting grounds or reintroduced into their natural habitats to restore wild populations (González-Redondo, García-Domínguez 2012). They can also be a source of valuable meat (Brudnicki et al. 2012). Research has shown that pheasant meat is characterized by high protein content, low fat content, desirable fatty acid composition, high concentrations of minerals and B vitamins, and exceptional sensory attributes (Franco, Lorenzo 2013, López-Pedrouso et al. 2019, Flis et al. 2020). Despite the above, the consumption of game meat, including pheasant meat, remains low (0.2 to 1.1 kg/person/year on average) – Czarniecka-Skubina et al. (2022), mostly because the market availability of game meat is limited whereas meat from farmed animals can be easily purchased (Ciobanu et al. 2023).

The supply of game meat can be increased by farming wild animals. However, farming captive cervids for food and non-food purposes has a long tradition (Kuba et al. 2015), whereas commercial pheasant farming is not highly popular (Kotowicz et al. 2012). The development of pheasant farms could contribute to diversifying market offer as well as increasing the popularity of and the demand for game meat.

In commercial farms, pheasants are kept in brooder houses for the first 5 to 7 weeks of their life, under adequate conditions (litter, light, temperature), with access to appropriate feed and water. Next, growing pheasants are transferred to large open-air pens or aviaries, where they stay until the end of the rearing period (sale) – González-Redondo, García-Domínguez (2012). Pheasants can also be raised in small amateur aviaries, in harems and colonies maintained in pens, in large complete-cycle farms, where groups of pheasants are kept with a male-to-female ratio of 1:5-7 (González-Redondo, García-Domínguez 2012).

A review of the literature conducted by López-Pedrouso et al. (2019) indicates that previous studies of farmed pheasants have focused on the effects of gender, age, and diet on carcass quality. The influence of housing conditions on the quality of pheasant meat remains insufficiently investigated (Augustyńska-Prejsnar et al. 2019, Boz et al. 2021). Therefore, existing research findings should be confirmed and supplemented with recent data. In view of the above, the research hypothesis in this study is that management conditions affect the quality of pheasant meat. In order to validate this hypothesis, a production trial was conducted to evaluate the effect of the aviary housing system on the chemical composition, fatty acid profile, and physicochemical and sensory properties of meat from male pheasants.

MATERIALS AND METHODS

Materials

Meat samples were collected from the carcasses of pheasants kept on a farm in north-eastern Poland (Game Breeding Center in Konopaty owned by the State Forests National Forest Holding). During the experiment, 14,000 pheasants were raised on the farm in one production cycle.

One-day-old chicks were purchased for rearing in Konopaty from another pheasant farm owned by the State Forests National Forest Holding. The birds were placed in two rearing houses with separate pens (400 birds per each) equipped with BIOS KE 500 electric brooders, and automatic drinkers and feeders. In each pen, the floor was bedded with fresh hardwood shavings on a layer of straw. At six weeks of age, pheasants were provided with access to four aviaries (7,852, 9,936, 8,568 and 9,126 m^2) enclosed with stainless steel wire mesh to a height of 4.5 m; the top was covered with string netting (control group, C). The aviaries were planted with lacy phacelia (*Phacelia tanacetifolia*), maize (*Zea mays*), field pea (*Pisum sativum subsp. arvense*), common pea (*Pisum sativum* L.), field mustard (*Brassica campestris*), and sunflower (*Helianthus annuus* L.), which constituted an additional feed source for birds, provided shelter from sunlight, and simulated natural environmental conditions (some adult pheasants were reintroduced into the wild).

A total of 32 males and 224 females (experimental group, E) were randomly selected from among six-week-old birds (group C) and were transferred to 32 small adjacent aviaries (1 male and 7 females per aviary). Each aviary had an area of 20 m^2 and a height of 2.5 m^2. The aviaries were separated with stainless steel wire mesh. The top of each aviary was covered with string netting. A feeder, a drinker and perches were mounted in the covered part of each aviary. The earth floor was sown with grass, and clusters of shrubs (roses and currants) were planted.

During the rearing period, group C and group E pheasants were administered commercial diets for birds of different ages (up to 4 weeks of age, from 5 to 9 weeks of age, from 10 to 16 weeks of age) (Daszkiewicz, Janiszewski 2020). At the end of rearing, pheasants were also fed *ad libitum* a mixture composed of wheat, oat and maize grain, cabbage and apples.

As part of business activities of the breeding center in Konopaty, pheasant carcasses are sold to retail customers. Birds are slaughtered (by severing the jugular vein), plucked, and eviscerated by farm employees. Such carcasses were analyzed in this study. The experimental materials comprised the carcasses of males that were randomly selected from groups C (n=8) and E (n=8) and slaughtered at 25 weeks of age. The number of birds was limited, and females were not analyzed because they were included in the batch of pheasants ordered by a foreign contractor.

Pheasant carcasses were transported to the laboratory in containers on ice, and they were stored in a cooling chamber (4°C) for 24 h. The right breast muscle (*Pectoralis major*) was cut out from each carcass and analyzed to determine meat quality.

Methods

Proximate chemical composition

The proximate chemical composition of the *PM* muscle was determined by standard methods (AOAC 2005). Moisture content was measured by drying the sample at 105°C to constant weight. Total protein content was determined by the Kjeldahl method in the Kjeltec™ 8400 Auto Distillation Unit (FOSS Analytical, Hillerod, Denmark). Fat content was determined by the Soxhlet method, with diethyl ether as the solvent, in the Soxtec™ 2050 Auto Fat Extraction System (FOSS Analytical, Hilleroed, Denmark). Protein and fat content was used to calculate the energy value of meat (energy factors for protein and fat of 16.78 kJ g^{-1} and 37.62 kJ g^{-1}, respectively; Jankowska et al. 2005).

Collagen content

The collagen content of the *PM* muscle was determined based on hydroxyproline content (ISO 3496 1994), which was converted into total collagen content using a conversion factor of 7.25 (Palka 1999).

Water-soluble nitrogen compounds

Aqueous meat extract was prepared as described by Herring et al. (1971) to determine the content of total nitrogen of water-soluble compounds by the Kjeldahl method. After protein precipitation with trichloroacetic acid, the content of nitrogen of non-protein compounds was determined.

Mineral content

Meat samples were mineralized in nitric acid (65%, 7 ml) using the MARS Xpress™ microwave digestion system (CEM Corporation, Matthews, NC, USA). The mineral content of meat was determined by atomic absorption spectroscopy using the AA240FS Fast Sequential Atomic Absorption Spectrometer and the AA240Z Zeeman Atomic Absorption Spectrometer with the GTA-120 Graphite Tube Atomizer (Varian Inc., Palo Alto, CA, USA). The concentrations of potassium (K), sodium (Na), magnesium (Mg), iron (Fe) and zinc (Zn) were determined by flame photometry (deuterium background correction) under standard conditions (air/acetylene flame). The concentrations of copper (Cu) and manganese (Mn) were determined by graphite furnace atomic absorption spectrometry (Zeeman background correction). Certified Standard Reference Material® (SRM) 1577c Bovine Liver was analyzed simultaneously with meat samples.

Fatty acid profile

Intramuscular fat (IMF) was extracted by the Soxhlet method, and fatty acids were esterified by the modified method of Peisker (Żegarska et al. 1991). Fatty acid methyl esters were separated by gas chromatography on the VARIAN CP-3800 gas chromatograph (Varian Inc., Palo Alto, CA, USA) equipped with a flame ionization detector (FID) and a capillary column (length – 50 m, inner diameter – 0.25 mm, liquid phase – CP-Sil 88, film thickness – 0.25 μm). The carrier gas was helium (flow rate – 1.2 ml min^{-1}). Fatty acids were identified by comparing the retention times of methyl esters in the analyzed samples and the standards (Supelco Inc., Bellefonte, PA, USA). The results were presented as percentages of individual fatty acids in total fatty acids in IMF, and they were used to calculate indicators of the nutritional quality of IMF.

pH value

Homogenates were prepared from each muscle sample (meat to redistilled water ratio of 1:1, m/v), and the pH value was measured with the use of a combination Polilyte Lab electrode (Hamilton) and the inoLab Level 2 pH-meter with a TFK 325 temperature sensor (WTW).

Meat color

Meat color parameters were determined in the CIELAB color space (CIE 1978). The values of L* (lightness), a* (redness), and b* (yellowness) were measured using the HunterLab MiniScan XE Plus spectrocolorimeter. The value of C* (chroma) was calculated using the following formula: $C^* = (a^{*2} + b^{*2})^{1/2}$. Measurements were performed in triplicate at different points over the inner muscle surface, and the arithmetic mean was calculated for each point.

Drip loss and cooking loss

The values of drip loss and cooking loss were calculated using the methods proposed by Honikel (1998).

Shear force

Meat samples were subjected to heat treatment as described by Honikel (1998). Five cylinder-shaped specimens (1.27 cm in diameter, 2 cm in height) were cut out from each sample. Each specimen was cut across the grain in the INSTRON 5542 universal testing machine fitted with a Warner-Bratzler head (500 N, speed 100 mm $min.^{-1}$). The maximum force required to cut the specimen was recorded. The results were used to calculate the arithmetic mean for each specimen.

Sensory analysis

Meat samples were subjected to heat treatment (0.6% aqueous solution of NaCl, 96°C, 1 h), and afterwards cubes (1 cm x 1 cm x 1 cm) were cut out from the center of each sample and presented to five panelists for a sensory evaluation. The panelists had been previously familiarized with the sensory properties of cooked pheasant meat during training sessions. The sensory attributes of meat (aroma, taste, juiciness, tenderness) were evaluated on a five-point scale (5 points – most desirable, 1 point – least desirable) during one session.

Statistical analysis

The results were processed statistically using STATISTICA software, ver. 13.3 (TIBCO Software Inc., Palo Alto, CA, USA). The significance of differences between group means was determined by Student's t-test at $p \leq 0.05$.

RESULTS AND DISCUSSION

The chemical composition of the *PM* muscle of pheasants is presented in Table 1. Housing conditions had a significant effect on the content of fat

Table 1

Chemical composition of the breast (*Pectoralis major*) muscle of male pheasants (*Phasianus colchicus*) housed in large (n=8) and small aviaries (n=8)

Item	Group		SEM	p-value
	large aviaries (group C)	small aviaries (group E)		
Water (%)	72.31	71.93	0.171	0.287
Fat (%)	0.29^{a}	0.18^{b}	0.026	0.042
Protein (%)	25.75	26.07	0.169	0.373
Water/protein (W/P) ratio	2.81	2.76	0.026	0.335
Collagen (%)	0.16^{a}	0.10^{b}	0.013	0.009
Total N of water-soluble compounds/ total N in meat ratio	27.69	27.80	0.257	0.837
N of water-soluble non-protein compounds/total N in meat ratio	15.02	14.84	0.234	0.720
Energy value (kJ)	442.87	444.26	2.859	0.818

SEM – standard error of the mean. Values in rows followed by different superscript letters are significantly different, ^{ab} – $p \leq 0.05$.

(p=0.042) and collagen (p=0.009) in muscle, which was higher in birds raised in large aviaries. However, the differences between group means were minor, at 0.11 and 0.06 percentage points, respectively. The percentages of the remaining chemical components and the energy value of meat were highly similar in both groups (Table 1).

The protein content of *PM* muscle in the present study was around 26%, which is comparable with the highest values noted in the *PM* muscle of pheasants by other researchers, whereas the fat content of meat was similar to the lowest values reported in the literature (López-Pedrouso et al. 2019). The present results corroborate the findings of other authors (Bogosavljević-Bošković et al. 2010, Baéza et al. 2022), who demonstrated that protein content was higher and fat content was lower in the *PM* of pheasants than in the *PM* of broiler chickens. The low IMF content of the *PM* muscle can be attributed to its histology. According to Weng et al. (2022), glycolytic fibers predominate in the *PM* muscle of poultry, and the high proportion of these fibers is negatively correlated with IMF content (Listrat et al. 2016).

The results of this study, which investigated the effect of two aviary housing systems on the quality of pheasant meat, are difficult to compare with previous research, which is scarce. One of the few studies on this topic was conducted by Boz et al. (2021), who found no significant differences in the proximate chemical composition of the *PM* muscle between pheasants aged 14, 16 and 18 weeks and raised under different production systems (indoor and outdoor). Wang et al. (2009), Zhao et al. (2014), and Michalczuk et al. (2017) also reported that housing conditions (indoor and outdoor) had no significant impact on the proximate chemical composition of the *PM* muscle in broiler chickens.

The low collagen content of the *PM* muscle of pheasants, observed in this study, is not surprising because it is a typical feature of poultry meat (Marangoni et al. 2015). Birds are usually slaughtered at a young age, whereas collagen content and the number of cross-links in collagen molecules increase with age (Purslow 2005). A lower proportion of collagen in total protein improves the nutritional value of meat (collagen lacks tryptophan, which makes an incomplete protein) – Paul et al. (2019) and its tenderness (a higher number of mature collagen cross-links makes meat less tender) – Weston et al. (2002). On the other hand, low collagen content may decrease the muscle's structural integrity (Maiorano 2017).

Research has shown that collagen content is higher in the muscles of free-range birds (Funaro et al. 2014, Lin et al. 2014, Molee et al. 2022), which can be attributed to their greater motor activity (Lin et al. 2014, Molee et al. 2022). In the present study, both groups of pheasants were housed in aviaries. Collagen content was somewhat higher in the *PM* muscle of birds raised in large aviaries, which promoted their movement.

It appears that increased motor activity should be accompanied by lower fat content of meat (Bogosavljevic-Boskovic et al. 2010, Funaro et al. 2014, Evaris et al. 2021). However, the results of studies investigating this relationship are inconclusive. Zhao et al. (2014) and Skřivan et al. (2015) demonstrated that the *PM* muscle of free-range broiler chickens tended to accumulate more fat. In the current study, the *PM* muscle of pheasants reared in large aviaries (which stimulated physical activity) also contained more fat. The relationship between motor activity and carcass fat deposition in livestock and poultry has not been studied to date, which makes it difficult to interpret the present findings.

In the group of the analyzed chemical elements (Table 2), significant differences between group means were found only in the content of Cu (p=0.033) and Mn (p=0.031). The concentration of Cu was higher (by 42.27%) in the *PM* muscle of pheasants raised in large aviaries, and the concentration of Mn was higher (by 16.08%) in the *PM* muscle of birds kept in small aviaries. The average levels of K, Na, Mg, Zn, and Fe in pheasant meat were similar in both groups.

The concentrations of K, Fe, and Cu in the *PM* muscle of pheasants noted in this study were higher than those reported by Franco and Lorenzo (2013), whereas the Mn content was lower. The levels of Na, Mg, and Zn were comparable in the present experiment and in the cited study. Straková et al. (2011) reported that the content of Ca and P was higher in pheasant muscles than in broiler chicken muscles. The effect of different production systems on the mineral composition of pheasant meat has not been researched to date. The concentrations of minerals in farmed animals and their meat are determined by the mineral content of their diets (Ribeiro et al. 2020). Green fod-

Table 2

Content of selected minerals[#] in the breast (*Pectoralis major*) muscle of male pheasants (*Phasianus colchicus*) housed in large (n=8) and small aviaries (n=8)

Item	Group		SEM	p-value
	large aviaries (group C)	small aviaries (group E)		
Potassium	3817.15	3908.61	36.029	0.215
Sodium	550.85	490.52	17.371	0.082
Magnesium	347.75	345.44	4.145	0.791
Zinc	6.72	6.42	0.327	0.667
Iron	15.35	16.31	0.276	0.080
Copper	2163.33^{a}	1248.83^{b}	221.348	0.033
Manganese	97.14^{b}	115.75^{a}	4.452	0.031

[#] expressed in mg per 100 g of wet tissue except for Cu and Mn (mg kg^{-1} of wet tissue).

SEM – standard error of the mean.

Values in rows followed by different superscript letters are significantly different, ^{ab} – $p \leq 0.05$.

der in outdoor runs can be a natural source of minerals for birds (Tufarelli et al. 2018, Jeni et al. 2021). Lin et al. (2014) analyzed Taiwan game hens and found that the muscles of free-range birds had higher Fe content and attributed this finding to increased myoglobin content, which could result from higher levels of physical activity in birds that had access to outdoor runs.

The fatty acid profile of the IMF of pheasants is presented in Table 3. The average proportions of the analyzed fatty acids or fatty acid groups in IMF did not differ significantly (p>0.05) between the examined housing systems. However, it should be noted that the proportion of saturated fatty acids (SFAs) was somewhat higher (by 4.16 percentage points) in the *PM* muscle of birds kept in small aviaries, whereas the proportions of monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs) were higher (by 1.64 and 2.51 percentage points, respectively) in the *PM* muscle of pheasants raised in large aviaries. The observed tendency to increased concentrations of unsaturated fatty acids (UFAs) in the *PM* muscle of these birds were reflected in slightly higher (p>0.05) values of nutritional quality indicators in IMF (Table 4).

In monogastric animals, the fatty acid profile of meat is closely correlated with the dietary inclusion levels of fatty acids (Kouba, Mourot 2011, Mir et al. 2017). In practice, various nutritional strategies can be applied to improve meat quality, such as feeding diets and additives with desirable fatty acid composition, i.e. abundant in PUFAs (Scollan et al. 2017). Plants are a rich source of PUFAs, which is why meat from monogastric animals provided with access to green outdoor spaces and pastures is characterized by more favorable (higher) PUFA/SFA and n-3/n-6 PUFA ratios (Prache

Table 3

Percentages of saturated and unsaturated fatty acids in the total fatty acid pool in intramuscular fat from the breast (*Pectoralis major*) muscle of male pheasants (*Phasianus colchicus*) housed in large (n=8) and small aviaries (n=8)

Item	Group		SEM	p-value
	large aviaries (group C)	small aviaries (group E)		
C 12:0	0.68	1.13	0.130	0.086
C 14:0	1.92	2.71	0.460	0.406
C 15:0	0.30	0.41	0.056	0.359
C 16:0	30.43	32.25	0.733	0.227
C 17:0	0.41	0.47	0.035	0.450
C 18:0	12.39	13.29	0.434	0.317
C 20:0	0.20	0.24	0.017	0.225
Saturated fatty acids (SFAs)	46.49	50.65	1.494	0.171
C 14:1	0.27	0.27	0.028	0.917
C 16:1	5.49	4.70	0.359	0.286
C 17:1	0.48	0.39	0.030	0.118
C 18:1	30.47	29.74	0.515	0.496
C 18:2	13.24	10.79	0.750	0.103
C 18:3	0.60	0.52	0.028	0.115
C 20:1	0.22	0.20	0.012	0.548
C 20:4	2.62	2.65	0.173	0.924
Monounsaturated fatty acids (MUFAs)	36.94	35.30	0.750	0.290
Polyunsaturated fatty acids (PUFAs)	16.57	14.06	0.893	0.167

SEM – standard error of the mean. Values in rows followed by different superscript letters are significantly different, ^{ab} – $p \leq 0.05$.

Table 4

Nutritional value of intramuscular fat from the breast (*Pectoralis major*) muscle of male pheasants (*Phasianus colchicus*) housed in large (n=8) and small aviaries (n=8)

Item	Group		SEM	p-value
	large aviaries (group C)	small aviaries (group E)		
UFA/SFA	1.17	1.00	0.058	0.147
MUFA/SFA	0.81	0.71	0.035	0.194
PUFA/SFA	0.37	0.29	0.025	0.124
DFA/OFA	1.97	1.73	0.090	0.198
EFAs*	13.85	11.30	0.770	0.100

SEM – standard error of the mean, SFAs – saturated fatty acids, MUFAs – monounsaturated fatty acids, PUFAs – polyunsaturated fatty acids, UFAs – unsaturated fatty acids (MUFAs + PUFAs), DFAs – desirable (hypocholesterolemic) fatty acids (UFA + C18:0), OFAs – hypercholesterolemic fatty acids (SFA – C18:0), EFAs – essential fatty acids (C18:2 + C18:3) et al. 2022). In the present study, no significant differences in the mean values of nutritional quality indicators in IMF were observed between the compared groups of pheasants. However, these values tended to be more desirable (higher) in the *PM* muscle of birds housed in large aviaries planted with various plant species that could be used as a source of supplemental feed. In the work of Boz et al. (2021), production system (intensive and free-range) had no significant effect on the nutritional value of IMF in pheasants, either. In contrast to the present study, the cited authors did not observe any specific tendencies in the values of the analyzed indicators depending on the production system.

No significant (p>0.05) differences were noted in the values of pH, color parameters (L*, a*, b*, C*), drip loss and cooking loss in the *PM* muscle of pheasants from both groups (Table 5).

Table 5

Physicochemical properties of the breast (*Pectoralis major*) muscle of male pheasants (*Phasianus colchicus*) housed in large (n=8) and small aviaries (n=8)

Item	Group		SEM	p-value
	large aviaries (group C)	small aviaries (group E)		
pH	5.70	5.68	0.017	0.500
L*	56.63	57.64	0.770	0.527
a*	10.60	10.46	0.296	0.827
b*	16.82	16.32	0.269	0.378
C*	19.92	19.40	0.288	0.383
Drip loss (%)	5.85	6.20	0.462	0.720
Cooking loss (%)	24.87	24.58	0.320	0.666

SEM – standard error of the mean.

In a study by Sarıca et al. (2021), the physicochemical properties of the *PM* muscle of pheasants were not significantly affected by different raising systems (indoor and free-range), either. Our results confirm the study of these authors. In turn, Augustyńska-Prejsnar et al. (2019) demonstrated that the *PM* and thigh muscles of pheasants raised in aviaries with access to a green paddock were characterized by higher values of L* (darker color) and b* (higher contribution of yellowness), and lower cooking loss than the muscles of birds kept in roofed aviaries without access to a paddock. However, the existence of a relationship between rearing conditions and the quality of pheasant meat is difficult to confirm due to an insufficient number of studies. A review of the literature indicates that different production systems (indoor and outdoor) have no significant influence on the values of pH, water-holding capacity or cooking loss in the muscles of broiler chickens (Wang et al. 2009, Połtowicz and Doktor 2011, Zhao et al. 2014, Michalczuk et al. 2017, Molee et al. 2022). In turn, an analysis of the effect of the above systems on the color parameters (L*, a*, b*) of the *PM* muscle produced inconclusive results in broilers (Funaro et al. 2014, Skřivan et al. 2015, Michalczuk et al. 2017, Molee et al. 2022). According to Molee et al. (2022), higher values of a* and b* in the muscles of chickens that had free access to an outdoor pasture could be attributed to the consumption of grasses containing carotenoid pigments.

A sensory evaluation (Table 6) of *PM* muscle samples revealed lower (p=0.048) aroma intensity in the meat of pheasants raised in small aviaries. Their meat also received somewhat lower scores (p>0.05) for other sensory attributes (excluding juiciness), i.e. aroma desirability, taste, and tenderness (reflected in slightly higher shear force values).

Table 6

Sensory properties (points) and shear force (N) values of meat from the breast (*Pectoralis major*) muscle of male pheasants (*Phasianus colchicus*) housed in large (n=8) and small aviaries (n=8)

Item	Group		SEM	p-value
	large aviaries (group C)	small aviaries (group E)		
Aroma – intensity	4.19^{a}	3.38^{b}	0.209	0.048
Aroma – desirability	5.00	4.75	0.125	0.334
Taste – intensity	4.25	3.94	0.172	0.382
Taste – desirability	5.00	4.88	0.063	0.334
Juiciness	3.69	4.25	0.180	0.120
Tenderness	4.88	4.44	0.135	0.106
Shear force	25.20	27.00	1.381	0.535

SEM – standard error of the mean. Values in rows followed by different superscript letters are significantly different, ^{ab} – $p \leq 0.05$.

According to the literature (El-Deek, El-Sabrout 2019), organic production systems and access to outdoor runs and pastures have a beneficial influence on the welfare and health status of broiler chickens, and on meat quality traits. This is partly consistent with the results of this study, where meat from pheasants raised in large aviaries promoting physical activity tended to score higher for sensory attributes (except juiciness). On the other hand, the current study corroborates findings from previous research suggesting the absence of a significant correlation between poultry housing systems and meat quality. For instance, Husak et al. (2008) reported no significant differences in the sensory properties of meat from organic, free-range and conventionally raised broiler chickens. Augustyńska-Prejsnar et al. (2019) demonstrated that texture and shear force values did not differ significantly between muscle samples collected from pheasants kept in aviaries with and without free access to a green paddock. In the work of Zhao et al. (2014), Michalczuk et al. (2017), and Molee et al. (2022), shear force values were higher in meat from broiler chickens raised with outdoor access. According to Molee et al. (2022), this could result from increased collagen content of meat and changes in muscle fibers induced by the locomotor activity of birds. Such a relationship was not observed in the current experiment because meat from pheasants reared in large aviaries was more tender and had lower shear force values despite higher collagen content, relative to those kept in small aviaries. One of the explanations could be a higher content of IMF in the *PM* muscle of pheasants housed in large aviaries.

CONCLUSIONS

Meat from pheasants was characterized by high quality regardless of housing conditions (large vs. small aviaries). Minor differences in the properties of the *PM* muscle, observed between experimental groups, could result from the availability of plant-based feed in large aviaries, and its absence in small aviaries. The results of the study suggest that the quality of meat from farmed pheasants is determined mostly by their diet.

Author contributions

T.D., P.J. – conceptualization, T.D. – data curation, T.D. – formal analysis, T.D., P.J. – funding acquisition, T.D., P.J. R.W., D.K., – investigation, T.D., P.J. – methodology, T.D., P.J. – project administration, T.D., P.J. – resources, T.D. – software, T.D., P.J. – supervision, T.D., P.J. – validation, T.D. – visualization, T.D., E.B., K.G, P.J., T.D. – writing – original drafting, T.D. – writing – review & editing. All authors have read and agreed to the published version of the manuscript.

Conflicts of interest

The authors ensure that they have neither professional nor financial connections related to the manuscript sent to the Editorial Board.

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