Influence of indoor and outdoor systems on meat quality of slow-growing chickens

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ABSTRACT

The aim of this study was to determine the effect of rearing system (with and without outdoor access) on carcass composition and meat quality in slow-growing chickens.

The highest shear force was found for the breast muscles of chickens from the outdoor group. Breast (P < 0.05) and leg (P < 0.01) muscles of the birds from the outdoor group were characterized by the highest content of vitamin E. Therefore, differences were observed in fatty acid composition. A lower level of saturated fatty acid (SFA) (P < 0.01), a higher level of n-3 polyunsaturated fatty acid (PUFA) (P < 0.05), and a lower n-6/n-3 PUFA ratio (P < 0.01) were found in breast and leg muscles of chickens from the outdoor group. The breast muscles of chickens from the outdoor group were characterized by a higher level of monounsaturated fatty acids (MUFA) (P < 0.01) and a lower level of n-6 PUFA (P < 0.05). The rearing system may modify the health-promoting properties of meat.

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RESUMEN

Se encontró la mayor fuerza cortante en los músculos del pecho de los pollos del grupo exterior. El pecho (P < 0,05) y la pata (P < 0,01) del grupo exterior de aves se caracterizó por tener el mayor contenido de vitamina E. Por esa razón, se observaron diferencias en la composición de ácidos grasos. Se encontraron un nivel inferior de ácidos grasos saturados (SFA) (P < 0,01), un mayor nivel de ácidos grasos insaturados n-3 (PUFA) (P < 0,05) y una menor proporción de PUFA n-6/n-3 (P < 0,01) en los músculos del pecho y las patas de los pollos del grupo exterior. Los músculos del pecho de los pollos de grupo exterior se caracterizaron por un mayor nivel de ácidos grasos monensaturados (MUFA) (P < 0,01) y un nivel inferior de PUFA n-6 (P < 0,05). El sistema de cría podría modificar las propiedades saludables de la carne.

Introduction

As a result of genetic progress in meat-type chicken breeding, birds grow very rapidly for about 35 days and achieve high body weights; 50 years ago, they still needed 12 weeks to achieve the same result (Havenstein, Ferket, & Qureshi, 2003). In the last 30 years, the growth period of broilers to reach 2 kg body weight has been shortened by half due to selective breeding. Genetic selection for rapid growth has gradually altered the behavior of birds, in particular their physical activity (Schütz & Jensen, 2001). According to Weeks, Danbury, Davies, Hunt, and Kestin (2000), 6-week-old chickens spend 76 to 86% of their time lying down. In birds, the rapid rate of growth coupled with uneven development of the body often leads to many abnormalities, such as sudden death syndrome, ascites, development of breast blisters, and leg disorders – femoral degeneration or tibial dyschondroplasia, deep pectoral myopathy (DPM), and white stripping (Havenstein et al., 2003; Mazzoni et al., 2015; Petracci, Mudalal, Bonfiglio, & Cavani, 2013). Dal Bosco, Mugnai, Sirri, Zamparini, and Castellini (2010) studied the impact of chicken genotype on their activity using the global positioning system. They found that the fast-growing chickens did not adapt well to organic production. Broilers tend to be inactive and do not benefit from large space allowances. For this reason, the medium- or slow-growing genotype is recommended for organic production.

The high nutritive value, low energy value, low fat content, desirable organoleptic attributes, and great potential for fortification of products make consumers increasingly interested in poultry meat and its products. Research results available to date show differences in physicochemical traits of meat between fast- and slow-growing chickens. The meat of slow-growing chickens is characterized by a higher protein content and low fatness desired by consumers (Michalczuk et al., 2016; Połtowicz, Wężyk, & Cywa-Benko, 2003).

The aim of this study was to determine the effect of rearing with and without outdoor access on meat quality in slow-growing chickens reared for 63 days.
Materials and methods

Animal material

The experiment was carried out at the experimental farm of the Warsaw University of Life Sciences (RZD Wilanów – Obory) in the springtime (April–June). Experimental procedures were approved by the Ethical Commission (approval no. 27/2009 of the 16 April 2009).

The experimental material was slow-growing experimental line chickens (only cockerels). The experimental line was the second generation of crossing Polish native Greenleg Partridge and fast-growing commercial chickens (Michalczuk, Damaziak, Łukasiwiec, & Tokarska, 2013).

Two-hundred and forty chickens from each group (control and experimental) in four replications with 60 chickens each were kept on litter in pens (11 chicks/1 m²) until 3 days of age. The birds were reared in two systems: the control group (indoor group) kept on litter over the entire rearing period, and the experimental group (outdoor group) with access to a grass area (year grass – 40%, red fescue – 40%, and common meadow grass – 20%) from the 4th week of life (daily from about 8 a.m. to about 5 p.m.). Experimental group chickens had access to free range conditions in an area of 6 x 5 m (2 birds/m²). The chickens had ad libitum access to feed and water. Table 1 presents the nutritive value of feed used in the study. The chemical composition and fatty acid composition of green forage and feed are presented in Tables 2 and 3.

Table 1. Composition and nutritional value of feed mixtures (%).

| Components | Starter (1–11 days) | Grower 1 (12–24 days) | Grower 2 (25–42 days) | Finisher (43–63 days) |
|------------|---------------------|-----------------------|-----------------------|-----------------------|
| Wheat      | 53.00               | 55.00                 | 59.60                 | 60.80                 |
| Maize      | 10.00               | 11.40                 | 10.00                 | 10.00                 |
| Soybean meal (46.5) | 30.60 | 27.40 | 23.20 | 21.60 |
| Limestone Ca39 | 1.19   | 1.20   | 1.11   | 0.97 |
| Sodium bicarbonate | 0.20   | 0.14   | 0.14   | 0.16   |
| NaCl (salt) | 0.24               | 0.28                 | 0.28                  | 0.26                 |
| Stimulator | 0.01               | 0.01                 | 0.01                  | 0.01                 |
| Dicalcium phosphate | 1.18   | 0.78   | 0.70   | 0.64   |
| Soybean oil | 2.10               | 2.40                 | 3.60                  | 4.40                 |
| MHA methionine | 0.48   | 0.42   | 0.36   | 0.28   |
| Lysine     | 0.36                | 0.34                 | 0.36                  | 0.40                 |
| Threonine  | 0.14                | 0.13                 | 0.14                  | 0.10                 |
| Premix2    | 0.50                | 0.50                 | 0.50                  | 0.50                 |
| Analysis   | ME (kcal/kg) 2990    | 3047                 | 3152                  | 3217                 |
| Crude protein | 21.99   | 20.78   | 19.26   | 18.51   |
| Crude fiber | 2.60               | 2.55                 | 2.45                  | 2.41                 |
| Crude fat  | 3.67                | 4.00                 | 5.14                  | 5.92                 |
| Crude ash  | 5.83                | 5.35                 | 4.96                  | 4.67                 |

1Stimulant – Crina Poultry Plus.
2The vitamin-mineral premix supplied the following per kilogram of complete feed: Ca 1005.165 mg; Mg 11.55 mg; Na 38.82375 mg; Se 0.315 mg; Fe 47.25 mg; Mn 115.5 mg; Zn 84.00 mg; Cu 21.00 mg; J 0.735 mg; vitamin A 11,550 IU; vitamin D 3,150 IU; vitamin E 44 mg; vitamin K 12 mg; vitamin B1 2.1 mg; vitamin B2 7.35 mg; vitamin B3 4.2 mg; vitamin B5 0.2625 mg; niacin 135.5 mg; D-pantothenic acid 16.8 mg; folic acid 1.575 mg; choline chloride 420 mg; biotin 0.2625 mg; 1-β-D-xylanase 262.5 FX; 6-phytase 2100 FX; ethoxyquin 0.1575 mg; citric acid (E330), 0.0945 mg; gallate, 0.02625 mg; 6-phytase, 2100 FT; ethoxyquin, 0.1575 mg; citric acid (E330), 0.0945 mg; gallate, 0.02625 mg; 1,4-

Chemical composition and fatty acid profile of grass (air-dry basis, %).

Table 2. Fatty acid profile of feed mixtures (%).

| Fatty acid | Starter (1–11 days) | Grower 1 (12–24 days) | Grower 2 (25–42 days) | Finisher (43–63 days) |
|------------|---------------------|-----------------------|-----------------------|-----------------------|
| SFA        | 20.33               | 19.78                 | 19.11                 | 19.44                 |
| MUFA       | 21.02               | 20.25                 | 21.58                 | 21.23                 |
| PUFA       | 58.61               | 59.94                 | 59.29                 | 59.30                 |
| PUFA n-6   | 52.87               | 53.77                 | 53.19                 | 53.24                 |
| PUFA n-3   | 5.74                | 6.17                  | 6.10                  | 6.06                  |
| PUFA n-6/n-3 | 9.21             | 8.71                 | 8.72                  | 8.79                  |

Table 3. Chemical composition and fatty acid profile of grass (a base de seco con aire, %).

| Chemical composition | Dry matter | 25.33 |
|----------------------|------------|-------|
| Total protein        | 7.52       |
| Crude fat            | 0.31       |
| Crude ash            | 3.36       |
| Crude fiber          | 9.85       |
| Fatty acid profile   |            |
| SFA                   | 31.20      |
| MUFA                  | 25.68      |
| PUFA                  | 43.12      |
| PUFA n-3              | 28.25      |
| PUFA n-6              | 14.87      |
| PUFA n-6/n-3          | 0.53       |

Table 4. Composición química y perfil de ácidos grasos de la hierba (a base de seco con aire, %).

| Chemical composition | Dry matter | 25.33 |
|----------------------|------------|-------|
| Total protein        | 7.52       |
| Crude fat            | 0.31       |
| Crude ash            | 3.36       |
| Crude fiber          | 9.85       |
| Fatty acid profile   |            |
| SFA                   | 31.20      |
| MUFA                  | 25.68      |
| PUFA                  | 43.12      |
| PUFA n-3              | 28.25      |
| PUFA n-6              | 14.87      |
| PUFA n-6/n-3          | 0.53       |

Table 5. Composición química y perfil de ácidos grasos de la hierba (a base de seco con aire, %).

Chemical analysis

Proximate chemical composition of meat was determined using standard procedures (AOAC, 2005).

Physical properties

The pH value of meat samples was assayed according to the Polish Standard (PN-ISO 2917:2001) with a CP-411 pH meter (Elmetron, Zabrze, Poland) using a combined glass-calomel electrode. The electrode was calibrated against buffers of pH 4.0 and 7.0. The meat samples were disintegrated twice in a meat grinder with a hole diameter of 3 mm and thoroughly mixed to assure homogeneity of the sample. In the prepared sample, the pH value was measured. Water holding capacity (WHC) was determined according to Grau and Hamm (1953), three replications of muscle were tested and the average value was taken as the result. Color parameters (a*, b*, L*) were analyzed with a Minolta CR-410 chroma meter using ground meat. Each measurement was carried out in five replications, taking their average value as the result. Parameter L* (color brightness) can
assume values from 0 to 100. Parameters a* (redness) and b* (yellowness) are tri-chromaticity coordinates. They can take positive or negative values; +a* corresponds to red, –a* to green, +b* to yellow, and –b* to blue.

Each measurement was carried out in five repetitions, taking their average value as the result. To determine cooking loss, breast and leg muscles were weighed to the nearest 0.01 g ($m_1$), and heated in a water bath at 90°C for about 30 min (until the internal temperature reached 75 ± 2°C in the geometric center). Cooked meat was cooled at room temperature for about 1 h and moved to a cold store room (4–6°C) for 24 h, after which it was weighed again ($m_2$). Cooking loss (%) was calculated using the formula: $Z = \frac{[m_1 - m_2]: m_1] \times 100$. Shear force (only breast muscles) was measured with the ZWICK 1120 tensile tester using a Warner-Bratzler blade. The maximum shear force ($F_{\text{max}}$) was measured at a cross-head speed of 50 mm/min. The meat sample was cut perpendicular to the muscle fibers. The test was finished when the shear force after cutting the sample decreased to 75% of the maximum force. Shear force was measured in five replications and the average value was taken as the result. The samples were prepared for the test by excising cuboids (1 cm × 1 cm × approx. 5 cm) from previously cooked breast muscles along the fibers.

TBA

2-Thiobarbituric acid (TBA) in abdominal fat was determined by the extraction method according to Shahidi (1990), which involved measuring the absorbance of color solution, the color of which developed as a result of the reaction between fat oxidation products (mainly malonaldehyde) and TBA. Approximately 2 g of fat was weighed into a centrifuge tube to the nearest 0.01 g, to which 5 cm$^3$ of 10% trichloroacetic acid was added; then the mixture was triturated for 2 min with a glass rod. Next, 5 cm$^3$ of 0.02 molar TBA solution was added and the sample was triturated again for 2 min and centrifuged for 10 min at 4,000 rpm. After centrifugation, the solution was filtered into a glass tube, and after sealing the opening with polythene sheeting, the color was developed for 24 h at room temperature. Afterwards, samples were collected for colorimetric determination. The absorbance was measured using a Hitachi U-1100 spectrophotometer at 532 nm against the reagent blank. The reagent blank was prepared by adding 5 cm$^3$ of 10% trichloroacetic acid and 5 cm$^3$ of 0.02 molar TBA solution to a glass tube. The result of the determination was expressed in absorbance units per gram of fat sample.

Fatty acid profile

Fatty acid profile was determined according to the Polish standard, PN-EN ISO 5509:2001. Fatty acids were separated using a gas chromatograph (Hewlett Packard 6890 Series GC System) with an FID detector and a BPX 70 capillary column (50 m × 0.25 mm × 0.25 μm film) by SGE Inc., Austin. Injection temperature was 220°C, column temperature was programmed to 1 min at 140°C, 1.5 min at 140/210°C, and 8 min at 210°C, and the sample was injected using a split ratio of 30:1. Helium was used as a carrier gas at a flow rate of 0.1 ml/min. Chromatograms were compared with Sigma standards, and fatty acid content was expressed as the percentage of the total amount of fatty acids determined.

Statistical analysis

The statistical analysis included the characteristics of the analyzed traits: arithmetic means and SE and the determination of the significance of differences in mean values between indoor and outdoor groups, by Duncan’s D test.

The results were analyzed statistically by one-way analysis of variance using SPSS 19.0 PL for Windows (SPSS, 2010). Significant differences were defined at $P < 0.05$.

Results and discussion

The study showed no effect ($P > 0.05$) of the rearing system on the chemical composition of breast and leg muscles of the chickens (Table 4). In contrast, Fanatico, Pillai, Emmert, and Owens (2007) observed changes in protein content of chicken meat as influenced by the rearing system. Meat of both the slow- and fast-growing birds with outdoor access was characterized by higher protein content. The authors concluded that it was likely associated with the greater activity of free range birds. Unfortunately, a lack of data in this study on the activity of birds kept indoor and outdoor makes explicit confirmation of this theory impossible. Dal Bosco et al. (2010) noted that only the slow-growing birds are more active in the outdoor system. For this reason, the assumption that perceived changes in the chemical composition of meat are dependent on activity of birds may be unfounded.

The pH values observed in the present study were not differentiated by the housing system (Table 4). The pH value of meat is largely determined by glycogen available in the muscles. Anaerobic glycolysis results in the synthesis of lactic acid, leading to a reduced pH value. The pH values observed in the present study were not differentiated by the housing system (Table 4). The pH value of meat is largely determined by glycogen available in the muscles. Anaerobic glycolysis results in the synthesis of lactic acid, leading to a reduced pH value.

### Table 4. Selected quality traits of breast and leg muscles of males depending on the type of rearing system.

| Traits                          | Indoor | Outdoor | SE   |
|--------------------------------|--------|---------|------|
| Breast muscle                  |        |         |      |
| Water content (%)              | 74.10  | 74.15   | 0.09 |
| Protein content (%)            | 23.29  | 23.54   | 0.06 |
| Fat content (%)                | 1.28   | 1.02    | 0.07 |
| Ash content (%)                | 1.24   | 1.12    | 0.01 |
| pH under h                    | 5.77   | 5.79    | 0.01 |
| Cooking loss (%)              | 18.13  | 18.09   | 0.51 |
| Shear force (N)                | 28.66b | 30.39a  | 0.45 |
| pH 24 h                       | 51.62  | 52.22   | 0.39 |
| a*                            | 1.84   | 1.73    | 0.18 |
| b*                            | 9.22   | 9.24    | 0.12 |
| Vitamin E mg/100 mg           | 11.23b | 14.52a  | 0.66 |
| Leg muscle                     |        |         |      |
| Water content (%)              | 73.78  | 74.02   | 0.14 |
| Protein content (%)            | 19.11  | 19.27   | 0.10 |
| Fat content (%)                | 5.87   | 5.49    | 0.18 |
| Ash content (%)                | 1.00   | 1.11    | 0.01 |
| pH under h                    | 6.17   | 6.25    | 0.03 |
| WHC                           | 26.13a | 23.72b  | 0.96 |
| WHC                           | 8.98   | 10.50   | 0.88 |
| L*                            | 55.24a | 54.23b  | 0.31 |
| a*                            | 5.88   | 5.89    | 0.25 |
| b*                            | 13.01a | 12.72b  | 0.16 |
| Vitamin E mg/100 mg           | 20.95a | 25.03a  | 1.90 |
| BHA in abdominal fat (48 h)    | 0.04   | 0.03    | 0.01 |
| BHA in abdominal fat (11 week) | 0.09   | 0.10    | 0.02 |

**Note:** Means with different superscripts differ significantly at $P < 0.01$ (in line).

**Note:** Means with different superscripts differ significantly at $P < 0.05$ (in line).

**Note:** Los promedios con diferentes superíndices difieren significativamente a $P < 0.01$ (en la línea).

**Note:** Los promedios con diferentes superíndices difieren significativamente a $P < 0.05$ (en la línea).
acid, which is responsible for a pH value decrease (Nissen & Young, 2006). A rapid pH drop may induce proteolysis of proteins, which in turn may result in decreased juiciness and brightening of meat. In contrast, Jiang et al. (2011) reported a significantly higher pH value in free range chickens. They explained the pH decrease in the conventionally reared chickens with a higher glycogen content in their muscles. An increase in physical activity, which is likely in the case of chickens reared with outdoor access, especially in the case of the slow-growing birds (Dal Bosco et al., 2010), may result in the consumption of glycogen reserves from muscles. According to Fanatico et al. (2007), lighter birds fight more strongly on the slaughter assembly, mainly by flapping their wings, which leads to a faster pH decline in their breast muscles. Similar results were obtained by Damaziak et al. (2015) who’s examined post-mortem changes in the breast muscle of turkeys with different growth rates.

No significant changes were observed in breast muscles of chickens from different rearing systems regarding the cooking loss (Table 4). In turn, leg muscles of the chickens with outdoor access were characterized by a significantly lower cooking loss. This result may be linked with a slightly higher pH value of these muscles. According to Jiang et al. (2011), such parameters as pH, cooking loss, and WHC are strongly correlated; therefore an increase in pH value may result in a reduced cooking loss and increased WHC. In our studies with slow-growing hybrids, we did not observe changes in the WHC values in breast and leg muscles as affected by the rearing system. Previously, similar results were obtained by Michalczuk, Łukasiewicz, Zdanowska-Sąsiadek, and Niemiec (2014), who analyzed the quality of meat from medium-growing chickens.

The study showed a significant effect of the rearing system on changes in the shear force determined in breast muscles. A higher shear force was found in the birds from the outdoor group (Table 4). This finding confirms results obtained by Chen et al. (2013), who concluded that the higher shear force resulted from the greater activity of the free range birds.

The color of fresh carcass meat is an important characteristic evaluated by consumers in the first place. The content of heme pigments and the resulting color of poultry meat depend on many factors, first of all on bird species, sex, age, nutrition, type of muscles and their in vivo activity, and degree of exsanguination (Fanatico et al., 2007). Color is also affected by the content of fat, structure of muscle tissue, and active acidity (pH) of meat (Grabowski & Kijowski, 2004; Poltowicz et al., 2003). The analysis of muscles showed a simple correlation between the active acidity of meat and color lightness L* (Table 4). According to Strżyżewski, Bilška, and Krysztofiak (2008), an increase in pH of meat reduces color lightness. The analysis of L*, a*, and b* values demonstrated that individual muscles differed in color lightness, which was not confirmed statistically for muscles. The highest L* value and thus the greatest lightness, was characteristic of leg muscles from male chickens in the indoor group (55.24 vs. 54.23 in birds from the outdoor group). The yellowness and blueness values are determined by the value of parameter b*. Results obtained for this parameter indicated that leg muscles were characterized by yellowness. According to Kirkpınar, Bozkurt, and Erker (2001), the color of broiler chicken carcasses is more favorable when L* values are lower and a* and b* values are higher.

The level of vitamin E in breast and leg muscles was significantly higher in chickens from the outdoor group (Table 4). A study conducted by Ponte et al. (2008) demonstrated that pasture is a very good source of vitamins, including vitamin E. Larsen et al. (2012) pointed to grass maturity and species composition of green forage as factors which influence the nutritive value of green forage, including vitamin E level. It is noteworthy, however, that as being roughage the green forage may be ingested by monogastric animals in a limited quantity owing to its significant volume. A study carried out by Dal Bosco et al. (2014) demonstrated that grass ingestion ranges from approximately 15 to 43 g of DM/d per bird according to the environmental enrichment of the pasture.

The oxidative stability of abdominal fat in chickens was determined by the TBA test, and the results obtained are presented in Table 4. The TBA values of abdominal fat from chickens in indoor and outdoor groups were similar both at 48 h postmortem and after 11 weeks of frozen storage (−18°C). Škívan, Pickinpaugh, Pavlí, Škívanová, and Englmairová (2015) reported a significant effect of the rearing system of birds on TBA level in meat. Although they observed no changes in TBA level 48 h after slaughter, which is in accordance with the results of our study, after 5-day cold storage of meat they observed increased TBA in meat of chickens reared in the conventional system. They explained this result with the almost twofold higher level of vitamin E in meat of chickens with outdoor access (Škívan et al., 2015). Being one of the strongest antioxidants, vitamin E could affect the inhibition of oxidation processes in meat (Polawska et al., 2011). The results of our study do not confirm such a high concentration of vitamin E in the free range chickens as in the research by Škívan et al. (2015) and Dal Bosco et al. (2016). In contrast, Michiels, Tagliaube, Akbarian, Ovyn, and De Smet (2014) observed a significantly lower level of vitamin E, and consequently a higher level of TBA, in muscles of free range birds. The results demonstrate that the main factor which determines TBA level is the content of antioxidants in meat (including vitamin E, being one of the key antioxidants). By affecting the content of antioxidants, the rearing system may have a significant effect on TBA level.

The study demonstrated a significant effect of outdoor access on contents of SFAs, MUFAs and n-6 and n-3 PUFAs in the analyzed breast muscles (Table 5). The breast muscles of chickens from the experimental group were characterized by lower contents of SFAs and n-6 PUFAs and by higher contents of MUFAs and n-3 PUFAs. As a result of decreased n-6 PUFA content and increased n-3 PUFA content, the n-6/n-3 PUFA ratio decreased significantly in the experimental group. Leg muscles were also characterized by lowered SFA content and increased n-3 PUFA content. As in the breast muscles, the n-6/n-3 PUFA ratio decreased in leg muscles of the chickens from the experimental group. Presumably this is due to the higher oxygen fiber content and greater amounts of phospholipids and other structure of cell membrane in leg muscles (working muscles). More oxidative muscles contain a higher phospholipid proportion due to the higher number of mitochondria (Raes, De Smet, & Demeyer, 2004).

Givens, Gibbs, Rymer, and Brown (2011) did not observe similar changes in the fatty acid profile in meat of free range chickens. It is worth noting that the only information provided by these authors concerns the type of rearing system.
Table 5. The total fatty acids (% of total fatty acids) composition in chicken muscles depend on the type of rearing system.

| Traits       | Indoor       | Outdoor      | SE  |
|--------------|--------------|--------------|-----|
| Breast muscle |              |              |     |
| SFA          | 28.73\textsuperscript{a} | 26.29\textsuperscript{b} | 0.32 |
| MUFA         | 35.89\textsuperscript{a} | 37.07\textsuperscript{b} | 0.22 |
| PUFA         | 34.04        | 33.77        | 0.23 |
| PUFA n-6     | 30.69        | 29.91\textsuperscript{a} | 0.18 |
| PUFA n-3     | 3.36\textsuperscript{a} | 3.85\textsuperscript{b} | 0.13 |
| PUFA n-6/n-3 | 9.22\textsuperscript{a} | 7.80\textsuperscript{b} | 0.31 |
| Leg muscle   |              |              |     |
| SFA          | 28.84\textsuperscript{a} | 26.69\textsuperscript{b} | 0.23 |
| MUFA         | 35.99        | 35.74        | 0.20 |
| PUFA         | 34.74        | 35.19        | 0.29 |
| PUFA n-6     | 31.27        | 31.32        | 0.23 |
| PUFA n-3     | 3.46\textsuperscript{a} | 3.86\textsuperscript{b} | 0.09 |
| PUFA n-6/n-3 | 9.04\textsuperscript{a} | 8.13\textsuperscript{b} | 0.19 |

\textsuperscript{a,b} - Means with different superscripts differ significantly at \( P < 0.01 \) (in line).

\textsuperscript{A, B} - Means with different superscripts differ significantly at \( P < 0.05 \) (en la línea).

\textsuperscript{A, B} - Los promedios con diferentes superíndices difieren significativamente a \( P < 0.01 \) (en la línea).

\textsuperscript{a,B} - Los promedios con diferentes superíndices difieren significativamente a \( P < 0.05 \) (en la línea).

(i.e. intensive free range). Based on results obtained by Dal Bosco et al. (2010), it has to be concluded that chickens with various growth rates exhibit different physical activities. These authors demonstrated that slow-growing birds were considerably more eager to use the free range area, covered a significantly longer distance per day and exhibited a significantly higher number of behaviors typical of birds such as ground pecking and wing flapping. They were also more willing to ingest green forage, which is a rich source of PUFA, including n-3 PUFA.

Conclusions
The rearing system may influence the health-promoting properties of chicken meat, including the fatty acid profile. The importance of genotype should not, however, be underestimated when choosing birds for the outdoor system. The slow-growing chickens far better adapt to difficult external conditions, and their meat may display health-promoting properties.

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No potential conflict of interest was reported by the authors.

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