Slaughter value and meat quality in two strains of Polish crested cockerels

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ABSTRACT

With increasing consumer awareness of animal welfare, and also on humanitarian grounds, the search is on to find the possibility of using slow-growing cockerels, which are becoming an alternative for conventional broilers. Therefore, the aim of this study was to evaluate slaughter value and meat quality in two new strains of Polish Crested cockerels: CP-11 (40 birds) and CP-22 (40 birds) which were raised for 25 weeks on a finishing diet based on whole wheat and oat grain. Carcase quality parameters (carcase weight, dressing percentage, leg and breast muscle percentage) were evaluated. Moreover, breast meat parameters (pH 24, cooking loss, colour, muscle fibre diameter, sensory traits, chemical composition, fatty acid profile) were determined. The results showed that CP-22 cockerels were characterised by significantly lower carcase weight ($p < .05$) and significantly higher dressing percentage ($p < .05$) compared to CP-11 cockerels. Genotype had no significant effect on breast meat quality parameters such as acidity, cooking loss, colour, as well as chemical composition of raw meat, tenderness, texture parameters, and muscle fibre size. On the other hand, breast meat from CP-22 cockerels was characterised by higher aroma desirability ($p < .05$) as well as higher content of nutritionally desirable fatty acids such as CLA ($p < .01$), GDLA ($p < .01$), AA ($p < .01$), EPA ($p < .05$), DPA ($p < .05$) and DHA ($p < .01$). Summarising, the obtained results indicated that the application of a similar model for the farming and feeding of surplus Polish Crested cockerels will provide a relatively large amount of meat, which can be used in traditional or alternative farming.

HIGHLIGHTS

- The cockerels of both strains exhibited high dressing percentage, their meat had a beneficial chemical composition and delicate texture.
- Breast meat from CP-22 cockerels was characterised by higher aroma desirability as well as higher content of nutritionally desirable fatty acids.
- The use of post-production cockerels of the CP-11 and CP-22 strains of Polish crested chickens may be a good choice for organic farming or free range.

Introduction

The domestic fowl is one of the earliest bird species farmed by humans (West and Zhou 1988; Xiang et al. 2014). It is also amongst the most plastic species, for there are countless varieties of domestic fowl that differ in many productive traits and adaptations. Of these, head crest has long been of special interest to breeders and scientists from different domains (Rehkämper et al. 2003).

It is known from historical records and accounts that crested breeds of chickens produced high quality meat. French large-crested chickens were used, especially before the Second World War, as special meat-producing breeds and their meat was considered exquisite (Szuman 1957). Crest is also a prominent feature of the native variety of chickens that have been widespread in Poland for centuries (Pietruski 1866); they possessed good productive traits and interesting external appearance (Trybulski 1925). In 2004 at the University of Agriculture in Kraków, work began on developing two strains of the Polish Crested breed (CP-11 and CP-22), for which a flock book was established in 2016 (Calik and Andres 2018). The genetic material was obtained in south-eastern Poland, mainly in the Podkarpackie voivodeship, from farmers who breed chickens naturally and purchase no commercial hybrids. Conformation of the breed is typical of...
traditional breeds from central Europe, with a medium-sized crest of feathers on the top of head. The average body weight is 1950–2100 g in roosters and 1300–1450 g in hens. Up to 64 weeks of age, the hens lay around 170 cream-coloured eggs weighing around 52 g. CP-11 birds have uniform black plumage with metallic green sheen and black shanks. CP-22 birds are characterised by partridge-like plumage and greenish shanks. In line with historical data, these multipurpose, undemanding, resistant and long-lived birds are used mainly to lay table eggs in traditional farms.

The fate of day-old male chicks is increasingly becoming an ethical issue where birds are used for egg production, as is the case with commercial hybrids (Leenstra et al. 2011; Bruijnis et al. 2015). Raising for meat production could be one of the ways of using day-old cockerels, especially when the genetic stock has adequate carcase meatiness and quality.

Slow-growing birds, including old breeds and varieties of poultry, are currently attracting increasing interest (Franco et al. 2013; Calik et al. 2015). These birds should be reared under non-intensive systems, the most popular of which are free range, ‘Label Rouge’, and organic farming. In the last-mentioned case, EU regulations state that in the choice of animals for organic farming, preference is to be given to indigenous breeds and strains of animals that have the capacity to adapt to local conditions concerning their vitality and their resistance to disease (CEU 2007).

When choosing slow-growing birds, it is possible to introduce innovative rearing practices that allow for the use of traditional feed raw materials, especially towards the end of rearing.

Feeding methods that account for finishing diet were found to influence carcase quality in slow-growing chickens. Franco et al. (2013) suggested that finishing feeding with grains affects meat colour and may increase the PUFA content in meat. Moreover, the use of whole cereal grains in poultry nutrition improves the gastrointestinal function by increasing the production of gastric juice and depth of jejunal crypts (Zdunczyk et al. 2013). Fibre contained in whole grain has a positive effect on intestinal peristalsis and on the health status of the digestive system by creating an environment for the proliferation of symbiotic bacteria responsible for the production of important compounds including vitamins (Bogucka et al. 2019; Raza et al. 2019).

The use of traditional genotypes enables development of methods for making region-promoting products, the price of which should cover expenses relating to slower growth rate and poorer feed conversion, as well as the need to provide more spacious housing or grassed runs. In the case of some local products obtained from traditional breeds, rearing period must be extended beyond the minimum for the birds to reach proper body weight and carcase tissue composition. This procedure was reported to have a beneficial effect on some meat quality traits (Franco et al. 2013).

There are no scientific data regarding the nutritional and technological value of meat of new Polish crested chicken strains, which would determine its dietary usefulness. Therefore, the aim of the study was to evaluate slaughter value and meat quality in two strains of Polish Crested cockerels, which were raised for 25 weeks on a finishing diet based on whole wheat and oat grain.

Materials and methods

Animals

All the animals were treated according to the principles stated by the Directive 2010/63/EU regarding the protection of animals used for experimental and other scientific purposes.

The study used 80 Polish Crested cockerels of two strains: CP-11 (40 birds) and CP-22 (40 birds), which were reared in a litter floor system at the Centre for Research and Education of the Faculty of Animal Breeding and Biology, the University of Agriculture in Kraków, Poland. Birds were fed ad libitum with complete diets (I – 0–56 d of age; II – 57–150 d of age), and whole grain population wheat and population oats at a 2:1 ratio (diet III – 151–175 d of age) in accordance with the requirements of the Poultry Feeding Standards (Smulikowska and Rutkowski 2018). The composition and nutrients content and concentration of fatty acids of mixtures as well as nutrients content and concentration of fatty acids of grains fed to growing cockerels is presented in Table 1.

Carcase quality measurements

At the end of the experiment (175 d), 12 birds whose body weights were similar to the group average, were selected from each group for slaughter. The slaughter in a commercial slaughterhouse and 24-h carcase chilling at 4 °C were followed by simplified slaughter analysis to determine dressing percentage, breast muscle percentage, and leg muscle percentage. All measurements were made using an analytical OHAUS PR 2202 balance (Newark, NJ, USA, e = 0.01). Next, breast muscles were sampled from each carcase to determine
the chemical composition, physicochemical, textural and sensory parameters, as well as fatty acid profile of the meat.

**Meat quality analysis**

Muscle pH was measured using a Matthäus (Germany) pH metre with an insertion electrode standardised for pH 4.0 and 7.0 according to Polish Standard PN-77/a-82058 with automatic correction for muscle temperature at 24 h (pH24) post-mortem. Meat colour was determined using a Minolta CR-310 chroma metre (Minolta Co., Ltd., Tokyo, Japan) with a 50 mm diameter measuring head in the CIE L*ab*b* system, where the L* parameter corresponds to the degree of lightness (L* = 0: black, L* = 100: white), a* and b* are colour components (a*>0 red, a*<0 green, b*>0 yellow, b*<0 blue). The chroma metre was calibrated against a white tile (Y = 93.8, x = 0.3136, y = 0.3192) (CIE 1986). Colour parameters were analysed on the inner surface of the breast muscle immediately after deboning.

For the determination of meat tenderness and textural parameters, breast muscle fragments weighing around 120 g were packed in aluminium foil and heat treated in an electric stove at 180°C to an internal temperature of 90°C. After heat treatment and cooling on ice, cooking loss was determined from meat weight loss, and sensory analysis and texture analysis were performed. Shear force [N] was measured with a TA-XT plus texture analyser (Stable Micro Systems) fitted with a Warner-Bratzler shear force attachment. To this end, meat samples (cubes with the shorter side length of 10 x 10 mm) were cut perpendicular to the muscle fibre orientation. The samples were cut across the muscle fibres until the samples were cut completely, at a penetration speed of 2 mm/s. At least four cuts from each cube were made, from which mean values were automatically calculated.

Texture profile analysis (TPA) was determined using the same texture analyser fitted with a 50-mm cylinder probe. Meat texture was measured on cube-shaped samples (10 mm). A double compression test was performed and the samples were compressed to 40% of their height, along the muscle fibre direction. Crosshead speed was 5 mm/s and the time between compressions was 5 s. The following texture parameters were determined: hardness [N], springiness, cohesiveness and chewiness [N]. During serial measurements, at least two tests were performed, from which the mean value was calculated, and all the texture parameters were automatically calculated. Shear force and TPA values were computed using Exponent for Windows ver. 6.1.10.0.

**Microstructural analysis**

For microstructural analysis the samples of breast muscle were taken immediately after slaughter of the birds (15 min) from the left fillet of each carcase. Muscle samples were cut into 1 cm³ pieces (parallel to the muscle fibres) and frozen in isopentane that was cooled using liquid nitrogen and stored at –80°C until subsequent analyses. Samples were mounted on a cryostat chuck with a few drops of tissue-freezing medium (Tissue-Tek; Sakura Finetek Europe, Zoeterwoude, The Netherlands). Transverse sections (10-μm thick) were cut at –20°C in a cryostat (Slee

### Table 1. Composition and nutrients content of the diets fed during the experiment.

| Item                        | I   | II  | III  |
|-----------------------------|-----|-----|------|
| Composition (% on fed basis) |     |     |      |
| Corn                        | 33.00 | 38.70 | –    |
| Wheat                       | 35.70 | 32.50 | 66.7 |
| Oat s                       | –    |     | 33.3 |
| Wheat bran                  | 0.00 | 5.00 | –    |
| Soybean meal                | 25.00 | 9.00 | –    |
| Rapeseed meal               | 3.00 | 5.00 | –    |
| Sunflower meal              | 0.00 | 6.50 | –    |
| Monocalcium phosphate       | 0.80 | 0.70 | –    |
| Limestone                   | 1.40 | 1.40 | –    |
| Mineral–vitamins premix     | 1.10 | 1.20 | –    |
| Nutrient content            |     |     |      |
| Crude protein (%)           | 19.04 | 15.52 | 12.19 |
| Crude fat (%)               | 2.05 | 2.41 | 2.80 |
| Crude fibre (%)             | 3.22 | 4.10 | 6.29 |
| Crude ash (%)               | 3.40 | 4.68 | 2.23 |
| Na (%)                      | 0.17 | 0.18 | 0.01 |
| Ca (%)                      | 0.94 | 0.91 | 0.07 |
| P (%)                       | 0.41 | 0.38 | 0.21 |
| Lysine (%)                  | 0.97 | 0.68 | 0.36 |
| Methionine (%)              | 0.48 | 0.34 | 0.17 |
| Metabolic energy (MJ)       | 11.65 | 11.55 | 12.02 |

Fatty acids content (g/100 g of total fatty acids)

| Fatty acid   | I   | II  | III  |
|--------------|-----|-----|------|
| 10:0         | 0.20 | 0.04 | 0.049 |
| 12:0         | 0.36 | 0.011 | 0.220 |
| 14:0         | 0.149 | 0.089 | 0.969 |
| 16:1         | 0.005 | 0.002 | 0.023 |
| 18:1         | 0.054 | 0.061 | 0.262 |
| 16:0         | 16.451 | 18.481 | 24.712 |
| 16:1n-9      | 0.229 | 0.200 | 0.423 |
| 16:1n-7      | 0.244 | 0.172 | 0.413 |
| 17:0         | 0.081 | 0.101 | 0.222 |
| 17:1         | 0.035 | 0.066 | 0.217 |
| 18:0         | 2.320 | 2.100 | 2.434 |
| 18:1n-9      | 19.801 | 18.750 | 19.363 |
| 18:1n-7      | 1.190 | 1.300 | 1.549 |
| 18:2n-6      | 55.554 | 54.843 | 42.823 |
| 18:3n-6      | 0.007 | 0.006 | 0.042 |
| 18:3n-3      | 3.316 | 3.306 | 4.100 |
| 20:0         | 0.268 | 0.259 | 1.609 |
| 20:1         | 0.244 | 0.252 | 0.563 |

Diets: I – 0–56 d of age; II – 57–150 d; III – 151–170 d.
FAME components (Supelco, Sigma-Aldrich Co., St. Louis, MO) and CLA isomers (Sigma-Aldrich Co., St. Louis, MO).

**Statistical analysis**

Calculations were made with Statistica 10. Statistical analysis accounted for arithmetic means (x) and standard errors of the meat (SEM). Significant differences between the means were estimated using Student’s t-test. Differences between the parameters were considered highly significant at $p < .01$, and significant at $p < .05$.

**Results and discussion**

The slaughter parameters of two strains of Polish Crested cockerels are presented in Table 2. The obtained results show that strain has no significant effect on the body weight of cockerels, but significantly affects carcase weight and dressing percentage ($p < .05$). Accordingly, CP-11 cockerels were characterised by significantly higher carcase weight and significantly lower dressing percentage in comparison with CP-22 birds. The other carcass quality parameters, namely breast muscle percentage and leg muscle percentage, were not significantly influenced by the value of these parameters. Breeding strains of Polish Crested are relatively young and so the literature provides no data about their slaughter performance. However, compared to 24-week-old cockerels of the Greenleg Partridge, an old Polish breed of native origin (Calik et al. 2015; Zawacka et al. 2017), CP-11 and CP-22 cockerels achieved slightly lower body weights on finishing cereal-based diets at 25 weeks of age. It is worth noting that the 25-week-old CP-11 and CP-22 cockerels analysed in the present study showed high dressing percentage and high leg and breast muscle percentages as for pure strains of egg-type chickens. Furthermore, the carcass breast muscle percentage of CP-11 and CP-22 cockerels was similar to that reported by Calik et al. (2015) in Greenleg Partridge capons at 24 weeks of age and by Kwiecień et al. (2015) in Zk strain of Greenleg Partridge capons at 23 weeks of age.

**Table 2. Dressing percentage of Polish Crested cockerels of strains CP-11 and CP-22.**

| Item                        | CP-11    | CP-22    | SEM   | p Value |
|-----------------------------|----------|----------|-------|---------|
| Preshlaughter weight (g)    | 1995.00  | 1990.50  | 33.046| .70     |
| Carcase weight (g)          | 1466.00* | 1400.50  | 27.928| .01     |
| Dressing percentage         | 73.48*   | 70.36*   | .436  | .02     |
| Leg muscle percentage       | 25.15    | 25.37    | .417  | .35     |
| Breast muscle percentage    | 17.33    | 17.51    | .239  | .12     |

*Within a rows different superscripts are significantly different ($p < .05$). SEM: standard errors of the mean.
This carcase conformation may make the cockerels of newly created strains especially suited to be used for meat production under traditional and alternative farming systems.

Physicochemical parameters such as pH, cooking loss, and chemical composition of meat determine both its nutritive value and culinary usefulness (Michalczuk et al. 2014). The effect of Polish Crested strain on the physicochemical parameters is presented in Table 3. Acidity is an important indicator of meat quality because it determines meat properties such as water holding capacity, tenderness, and colour (Poltowicz 2000). In our study, was observed no significant effect of the Polish Crested strain on meat acidity at 24 h post-mortem and, importantly, the pH24 values obtained for the meat of CP-11 and CP-22 strains ranged from 5.6 to 6.1. This, according to the study of Pietrzak et al. (2013), allows this meat to be classified as normal meat.

Customers base their buying decisions on meat colour, which is an important attribute. It is one of the major determinants of meat freshness and its technological suitability as raw material, as well as an important characteristic by which meat dishes are judged during consumption (Magdelaine et al. 2008; Milan et al. 2011; Marcinkowska-Lesiak et al. 2013). Meat colour is determined by the content of haem pigments, the amount of which depends largely on bird genotype, age, sex, diet, as well as muscle type and activity (Mancini and Hunt 2005; Augustynska-Prejsnar and Sokolowicz 2014). Our study demonstrated no significant differences between the analysed strains of cockerels in all colour parameters. The results obtained for lightness (L*) and redness (a*) are in agreement with the results of Calik et al. (2015) for Greenleg Partridge cockerels aged 24 weeks. On the other hand, for both strain CP-11 and CP-22, our redness (a*) results are significantly higher compared to the a* value of breast muscles from typical broilers (Akter et al. 2017), or even from native meat breeds fattened for demanding markets (Franco et al. 2013), which is indicative of darker colour of the muscles from the analysed Polish Crested strains. According to Puchala et al. (2014), dark meat from chickens can be prepared just like game bird meat. The meat colour parameters of the cockerel genotypes analysed in the present study could have been considerably influenced by the use of finishing diets based on wheat and oats. Akter et al. (2017) showed that the meat of broilers fed wheat-based diets is lighter and more red compared to the meat of those raised on maize-based diets. In turn, oats fed to poultry show their strong antioxidant activity (Lopez-Bote et al. 1998), which improves the taste and shelf life of the meat.

An important determinant of the technological quality of meat is cooking loss, which shows possible meat weight loss due to water loss during processing (Pospiech and Montowska 2011). According to Pietrzak et al. (2013), cooking loss is undesirable due to the loss of soluble meat components, reduced juiciness, and economic losses. Studies by Alina et al. (2012) and Choi et al. (2016) suggest that the extent of meat losses during cooking depends mainly on product temperature, and to a lesser extent on processing time, as well as the initial water and intramuscular fat content (Sokołowicz et al. 2016). Therefore, the fact that we showed no significant differences in the value of this parameter between the analysed genotypes (p < .05) probably results from no differences in chemical composition of the breast muscles from the CP-11 and CP-22 strains (Table 4). On the other hand, the higher values of this parameter shown in our study for CP-11 and CP-22 cockerels compared to 24-week-old Greenleg Partridge cockerels investigated by Calik et al. (2015), may spread from the different heat treatment methods of meat.

Muscle fibre diameter is one of the factors influencing many biochemical processes in meat, which, in turn, determine its ultimate quality. Our study, which analysed two Polish Crested strains, namely CP-11 and CP-22, showed that genotype has no significant effect on muscle fibre size (Table 3). However, compared to 24-week-old Greenleg Partridge cockerels (Calik et al. 2015; Gesek et al. 2017) and 24-week-old Lenghorn

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**Table 3.** Muscle fibre diameter and physicochemical parameters of breast meat from Polish Crested cockerels of strains CP-11 and CP-22.

| Item                        | CP-11    | CP-22    | SEM    | p Value |
|-----------------------------|----------|----------|--------|---------|
| Muscle fibre diameter (μm)  | 37.2     | 37.5     | 0.286  | .29     |
| pH24                        | 5.79     | 5.77     | 0.043  | .66     |
| Cooking loss (%)            | 21.31    | 21.90    | 0.645  | .32     |
| CIE L*                      | 55.93    | 53.88    | 0.658  | .79     |
| CIE a*                      | 10.45    | 11.59    | 0.391  | .89     |
| CIE b*                      | 10.18    | 10.42    | 0.253  | .72     |

SEM: standard errors of the mean.

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**Table 4.** Chemical composition of raw meat (%) from breast meat of Polish Crested cockerels of strains CP-11 and CP-22.

| Item           | CP-11    | CP-22    | SEM    | p Value |
|----------------|----------|----------|--------|---------|
| Dry matter     | 27.02    | 27.52    | 0.061  | .55     |
| Crude protein  | 24.39    | 24.86    | 0.116  | .83     |
| Fat            | 1.72     | 1.73     | 0.050  | .06     |
| Ash            | 0.91     | 0.93     | 0.011  | .07     |

SEM: standard errors of the mean.
cockerels (Gesek et al. 2019) and also hybrids of Rhode Island Red cockerels (R-11) and Yellowleg Partridge hens (Ż-33) (Wojtysiak et al. 2019), the strains analysed in our study were characterised by considerably smaller muscle fibres, which shows the high growth potential of the breast muscles of the discussed birds.

Consumers consider palatability, juiciness, tenderness, aroma and structure to be important parameters of poultry meat quality. Sensory traits depend mainly on the slaughter age of birds, their genotype, environmental factors, and heat treatment methods (Horsted et al. 2012; Alina et al. 2012; Michalczuk et al. 2014). As reported by Kólczak (2007), mouthfeel evaluation of the palatability of meat products separately determines sensory attributes such as taste and aroma intensity and desirability. Our sensory analysis (Table 5) showed that for most of the analysed traits, the quality characteristics obtained for strains CP-11 and CP-22 were at a similar level and did not differ significantly except for aroma, where higher aroma desirability (p < .05) was characteristic of the meat from CP-22 cockerels. Tenderness of breast meat from CP-11 and CP-22 cockerels can be considered as moderate in comparison with other textural parameters of the meat (Takahashi 2018) and indirectly on sensory properties of the final product.

Heat treatment has the most significant effect on the sensory quality of meat. Proper meat tenderness is determined by multiple factors, in particular bird age, diet, rearing conditions, degree of fatness, structure of the connective tissue matrix, and the degradation rate cytoskeletal proteins post-mortem (Wojtysiak et al. 2008; Półtowicz and Doktor 2011; Naveena et al. 2013; Tougan et al. 2013; Wojtysiak 2014).
strain CP-22 tended to show a more favourable n6 to n3 fatty acids ratio. These results indicate that CP-22 meat has a more desirable composition of fatty acids that are beneficial from the standpoint of human nutrition (Pateiro et al. 2018).

The fatty acid profile has a significant impact on the taste of poultry meat. From a nutritional point of view, meat of free range birds is healthier because it has a lower fat content and a higher n-3PUFA, and, therefore, meets consumer expectations for organic products (Siri et al. 2011).

The existence of strong correlations between the diet and fatty acid level in broiler meat was indicated in the studies carried out by Kanakri et al. (2018), which allow predicting the fatty acid tissue profile based on their fat composition in the diet. In turn, Dal Bosco et al. (2012) showed differences in meat fatty acid composition between poultry genotypes. For proper human nutrition, more favourable meat composition was observed in the genotypes of slow growing chickens. Therefore, the above research can be used in the poultry selection aimed at obtaining, in ecological or organic farming systems, healthier meat intended for more aware consumers.

## Conclusions

In summary, it is stated that the cockerels of both strains exhibited high dressing percentage, their meat had a beneficial chemical composition and delicate texture, and breast meat of CP-22 strain was characterised by a more desirable composition of nutritionally beneficial fatty acids. The application of a similar model for the farming and feeding of surplus Polish Crested cockerels will provide a relatively large amount of meat, which can be used under traditional or alternative farming systems.

## Disclosure statement

The authors declare that there is no conflict of interest associated with the paper. The authors alone are responsible for the content and writing of this article.

## Ethical Approval

The experimental methods were approved by the national committee for ethics in animal research in Poland.

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## Table 7. Composition (%) of some fatty acids in the breast meat of Polish Crested cockerels of strains CP-11 and CP-22.

| Item                  | CP-11          | CP-22          | SEM  | p Value   |
|-----------------------|----------------|----------------|------|-----------|
| ΣFA                   | 37.866         | 38.264         | 0.416| .44       |
| ΣFA                   | 62.467         | 62.002         | 1.130| .85       |
| ΣMUFA                 | 38.079         | 36.738         | 0.559| .59       |
| ΣPUFA                 | 24.388         | 25.264         | 0.570| .72       |
| C18:2n-6 (LA)         | 14.092         | 13.246         | 0.204| .16       |
| C18:3n-6 (GLA)        | 0.099          | 0.091          | 0.001| .18       |
| C18:3n-3 (ALA)        | 0.377          | 0.314          | 0.009| .47       |
| C18:2n-11 (CLA)       | 0.024A         | 0.026B         | 0.001| .01       |
| C20:3n-6 (DGLA)       | 0.351A         | 0.366B         | 0.009| .01       |
| C20:4n-6 (AA)         | 6.461A         | 7.741B         | 0.225| .00       |
| C20:5n-3 (EPA)        | 0.039A         | 0.043B         | 0.001| .04       |
| C22:5n-3 (DPA)        | 0.756a         | 0.868b         | 0.035| .01       |
| C22:6n-3 (DHA)        | 0.715a         | 0.900b         | 0.027| .00       |
| Σn6                   | 22.266         | 22.889         | 0.491| .72       |
| Σn3                   | 1.898          | 2.139          | 0.073| .53       |
| n6/n3                 | 11.734         | 10.699         | 0.876| 1.36      |

*Within a rows different superscripts are significantly different (p < .05); SEM: standard errors of the mean; SFA: Saturated fatty acids; UFA: Unsaturated fatty acids; PUFA: Polyunsaturated fatty acids; MUFA: Monounsaturated fatty acids; LA: Linoleic acid; GLA: Gamma-linolenic acid; ALA: Alpha-linolenic acid; CLA: Conjugated linoleic acids; DGLA: Dihomo-gamma-linolenic acid; AA: Arachidonic acid; EPA: Eicosapentaenoic acid; DPA: Docosapentaenoic acid; DHA: Docosahexaenoic acid; n6: Omega-6 fatty acids; n3: Omega-3 fatty acids.
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