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# The Effect of Freezing Storage on Physical and Chemical Properties of Wild Boar Meat

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**Abstract**

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The colour, chemical composition, texture parameters, hydration properties and fatty acids profile of fresh wild boar meat and meat after 2 months of freezing were compared. The research material was the *M. longissimus dorsi* muscle cut out of wild boar carcasses (*Sus crofa*). Analyses of physical and chemical properties of samples taken from 16 boars were performed. Samples were packed and frozen to –18°C and stored under such conditions for a period of two months. Freezing storage significantly increased the elasticity value and the colour of the meat as indicated by the decrease in $L^*$ and $b^*$ values. In frozen meat there slightly increased thermal drip and forced drip. The changes in the fatty acid profile under the effect of freezing were found more often in fat from muscle *M. longissimus dorsi* than in back fat of wild boar. In conclusion, it should be noted that freezing storage in a short time does not affect negatively the quality of frozen meat.

**Keywords**: fatty acids; freezing storage; texture; meat quality

Wild boars have recently developed into permanent populations in many countries. This gives the opportunity to use this species as a source of interesting food (Amici *et al*. 2015). Venison with high nutritional value and special sensory properties is desired by consumers and considered an important source of healthy food (Strazdina *et al.* 2014).

Free-living animals are provided with well-being and unrestricted access to natural pastures, making a free choice of food. This way of feeding means that game meat, unlike meat of farm animals, does not contain residues from high-yielding farming technology (Kasprzyk 2015).

Venison has become popular among consumers due to its particular sensory properties and high nutritional value resulting from low fat and cholesterol content as well as high protein and mineral content (Daszkiewicz *et al.* 2015). However, compared to pork, the meat is darker and harder (Sales & Kotrba 2013). The possibility of culinary or processing use of wild boar meat, with its ever-increasing acquisition, justifies the need to conduct research aimed at better understanding of properties of this raw material (Górecka *et al.* 2012). Despite the striking differences in the muscle composition between wild boar meat and pork, which has a significant impact on the quality of meat, the physical properties of venison were not studied in great detail. There is a lack of serious research on hunting wild boars that can improve meat productivity and quality. In addition, although wild boar meat creates an excellent opportunity to use it in processed products, few studies have assessed its processing properties and acceptability in various final products (Sales

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& Kotrba 2013).The possibility of culinary or processing use of wild boar meat, with its ever-increasing acquisition, justifies the need to conduct research aimed at better understanding of properties of this raw material (Górecka *et al.* 2012). Despite the striking differences in the muscle composition between wild boar meat and pork, which has a significant impact on the quality of meat, the physical properties of venison were not studied in great detail (Sales & Kotrba 2013). Sensory quality is conditioned by the composition of meat (morphological, physical and chemical) and processes occurring during storage (Borilova *et al.* 2015).

The composition of fatty acids of muscles and fat determines the nutritional value and influences various qualities of meat quality, including durability and taste (Wood *et al.* 2008). It is also characterized by the desired low concentration of saturated fatty acids and the high concentration of long-chain polyunsaturated *n*-3 and *n*-6 fatty acids (Amici *et al.* 2015). Oxidation of lipids is the main cause of deterioration in quality of meat and meat products, resulting in an unpleasant smell, deterioration in colour and texture. Many authors confirm the importance of hunting stress for quality of meat and stability of lipids. Also important is the time between shooting and gutting of the animal, and subsequently followed by its processing and cooling (Ciffuni *et al.* 2014).

The profile of fatty acids in fat tissue and muscles depends on such factors as diet, species, fatness, age/weight, storage place, gender, race, as well as season and level of hormones (Dannenberger *et al.* 2013).The fatty acids profile is more important for consumers than the total fat content and that is why it is important to assess the composition of fatty acids and the sum of saturated, monounsaturated and polyunsaturated fatty acids (Strazdina *et al.* 2012). The *n*-6/*n*-3 ratio is widely used as an indicator to assess the nutritional value of food fat, which is particularly important for human health. The modern diet is low in *n*-3 and rich in SFA and *n*-6 PUFA. Increased *n*-3 consumption has been shown to have a protective effect in a variety of diseases, from atherosclerosis to inflammatory and autoimmune diseases (Marchioli & Levantesi 2013; Shantakumari *et al.* 2014; Strazdina *et al.* 2014; Kiyabu *et al.* 2015; Joumard-Cubizolles *et al.* 2017).The aim of the work was to compare the colour, chemical composition, texture parameters, hydration properties and fatty acids profile of fresh wild boar meat and meat after 2 months of freezing.

## MATERIAL AND METHODS

***Material***. The research material was the *M. longissimus dorsi* muscle cut out of wild boar carcasses (*Sus crofa*). Meat samples were collected in the autumn of 2017. Analyses of physical and chemical properties of samples taken from 16 boars were performed. Wild boars were obtained from the area of south-eastern Poland. The animals had access to agricultural crops (potatoes, maize, etc.). Out of the right half-carcasses, after 48 h from hunting, two samples of muscle and back fat with a weight of 600 g were obtained. To analyze the quality of fresh meat, one sample was selected from each carcass, the remaining samples were frozen. Samples intended for freezing were packed in PE-HD foil packages and frozen to –18°C and stored under such conditions for a period of two months. Thawing was carried out at 4°C within 24 hours. After thawing, the same set of quantitative and qualitative analyses was performed.

***Sample analysis***. Fresh meat tests were carried out 48 h after hunting. The water content was determined in accordance with PN-ISO 1442:2000. The meat samples mixed with sand were dried until constant mass was obtained at 103 ± 2°C. Fat content according to PN-ISO 1444:2000. The protein content was determined as the total nitrogen content by the Kieldahl method and using the coefficient 6.25 (ISO 937: 1974) for the calculation. Instrumental colour measurement in the CIE $L^*$ $a^*$ $b^*$ system was made using the electronic colorimeter NR20XE (light source D65, head opening measuring 20 mm, white colour calibration: $L^*$ –99.18, $a^*$ –0.07, $b^*$ –0.05). The measuring geometry of 45°/0° has been used. During the measurement, the colorimeter was coupled with the computer in which the CQCS3 software version 3.4 EN was installed. In this system $L^*$ is the brightness which is the spatial vector, while $a^*$ and $b^*$ are the coordinates of trichromaticity, where the positive $a^*$ values correspond to the red colour, the negative – the green colour, the positive $b^*$ – yellow, negative $b^*$ – blue.

The forced drip was determined by the Grau-Hamm (1953) method modified by Pohja & Ninivaara (1957). The thermal drip was determined using the method according to Walczak (1959). Samples weighing 20 g of ground meat were wrapped in gauze and placed in a water bath at 85°C for 10 minutes. After removal, it was cooled for 30 min at 4°C and then weighed again. The water

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loss was calculated from the difference in weight of the sample before heating and after cooling, and the result was expressed as percentage.

To determine the fat content the samples were extracted with petroleum ether in a Soxhlet extraction apparatus and then the fat content was calculated. The content of fatty acids was determined using a Varian 450-GC gas chromatograph with an FID detector. Galaxie™ Chromatography Data System software was used to control the chromatograph, collect, integrate and recalculate the results. Autosampler (Varian CP-8400; Varian Inc., USA), dispenser (1177 Split/Splitless; Varian Inc., USA), capillary column (Selec™ Biodiesel for FAME; Agilent Technologies, USA); L (m) × ID (mm) × OD (mm) – 30 × 0.32 × 0.45. The flow rate of helium was 1.5 ml/min, the temperature of the FID detector was 300°C, the injection volume was 1 µl, the temperature of the oven of columns was programmed from 100°C to 235°C, the total analysis time was 38 minutes. The results for individual fatty acids were presented as percentage of all identified fatty acids in the fat extracted from a given sample and calculated in g/100 g of the tested sample.

To determine texture parameters, cubes with a side length of 2 cm were cut out from meat using a Brookfield CT3 texture analyzer with a cylindrical attachment 30 mm in diameter, 36 mm in height. A 2-fold sample compression test was carried out up to 50% of their total height. The travel speed of the roll during the test was 2 mm/s, and the interval between pressures was 2 seconds. Using Texture Pro CT program, parameters such as hardness, elasticity, gumminess, chewiness, cohesion and adhesion were determined.

***Statistical analysis.*** The collected results were described using the Statistica 12 PL (StatSoft Inc.) statistical package. The means for each group and the standard deviations were calculated, the univariate analysis of variance was used and homogeneity of variance was tested using the Levene's test. The significance of differences between the means was determined using the Tukey HSD test at $P \leq 0.05$ and $P \leq 0.01$.

## RESULTS AND DISCUSSION

The content of protein in fresh *M. longissimus dorsi* of wild boar was 20.59%. Amici *et al.* (2015) showed some protein content which varied depending on the hunting area from 20.67% to 21.84%. An even higher protein content of 22.92% was found by Strazdina *et al.* (2013), and by Ivanović *et al.* (2013) 23.67%. Frozen storage caused a slight increase in protein content to 20.74%, which was due to decrease in water content. Water content in fresh meat was 74.6%, and after frozen storage 73.69%. A lower content

Table 1. Effect of freezing on the physical properties of *M. longissimus dorsi* of wild boar

| Specification | Meat before freezing | Meat after freezing |
|---|---|---|
| Fat (%) | 2.82 ± 1.66$^{a}$ | 2.61 ± 1.75$^{b}$ |
| Moisture (%) | 74.60 ± 2.95$^{a}$ | 73.69 ± 1.38$^{b}$ |
| Protein (%) | 20.59 ± 1.06$^{A}$ | 20.74 ± 0.32$^{B}$ |
| Cooking loss (%) | 25.21 ± 2.44 | 26.18 ± 2.17 |
| Water holding capacity (cm$^2$) | 6.51 ± 2.34 | 6.74 ± 2.21 |
| Hardness Cycle 1(N) | 114.03 ± 85.81 | 104.46 ± 46.61 |
| Adhesiveness (mJ) | 1.35 ± 0.52 | 2.05 ± 1.19 |
| Hardness Cycle 2 (N) | 71.64 ± 51.61 | 71.64 ± 21.99 |
| Cohesiveness | 0.26 ± 0.06 | 0.25 ± 0.05 |
| Springiness (mm) | 3.27 ± 0.52$^{A}$ | 4.86 ± 1.55$^{B}$ |
| Gumminess (N) | 26.24 ± 17.82 | 24.94 ± 8.91 |
| Chewiness (mJ) | 90.60 ± 69.07 | 117.93 ± 53.26 |
| Lightness ($L^*$) | 44.50 ± 1.89$^{A}$ | 40.25 ± 2.77$^{B}$ |
| Redness ($a^*$) | 23.87 ± 3.20 | 23.12 ± 1.27 |
| Yeloowness ($b^*$) | 10.62 ± 1.41$^{A}$ | 9.16 ± 0.62$^{B}$ |

Means within a row with different letters are significantly different; $^{A,B}$ $P < 0.01$; $^{a,b}$ $P < 0.05$

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Table 2. The effect of freezing on the profile of fatty acids of back fat and fat of *M. longissimus dorsi* of wild boar

| Specification | Back fat | | Fat of *M. longissimus dorsi* | |
|---|---|---|---|---|
| | before freezing | after freezing | before freezing | after freezing |
| C6:0 | 0.04 ± 0.01 | 0.01 ± 0.01 | 0.01 ± 0.01 | 0.01 ± 0.01 |
| C8:0 | 0.09 ± 0.02$^{A}$ | 0.02 ± 0.01$^{A}$ | 0.02 ± 0.01 | 0.02 ± 0.01 |
| C10:0 | 0.16 ± 0.02$^{A}$ | 0.08 ± 0.02$^{A}$ | 0.08 ± 0.02 | 0.09 ± 0.02 |
| C11:0 | 0.06 ± 0.01$^{A}$ | 0.00 ± 0.00$^{A}$ | 0.00 ± 0.00 | 0.00 ± 0.00 |
| C12:0 | 0.11 ± 0.03$^{A}$ | 0.07 ± 0.02$^{A}$ | 0.07 ± 0.02 | 0.08 ± 0.02 |
| C13:0 | 0.03 ± 0.01 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 |
| C14:0 | 1.25 ± 0.36 | 1.26 ± 0.29 | 1.26 ± 0.30 | 1.24 ± 0.37 |
| C14:1*n*5 | 0.02 ± 0.01 | 0.02 ± 0.01 | 0.02 ± 0.01 | 0.03 ± 0.01 |
| C15:0 | 0.03 ± 0.01 | 0.03 ± 0.01 | 0.03 ± 0.01 | 0.03 ± 0.01 |
| C16:0 | 24.69 ± 4.63 | 24.77 ± 2.46 | 24.77 ± 3.25 | 24.29 ± 4.21 |
| C16:1*n*7 | 2.31 ± 0.58 | 2.30 ± 0.51 | 2.30 ± 0.44 | 3.54 ± 0.56 |
| C17:0 | 0.22 ± 0.08 | 0.22 ± 0.05 | 0.22 ± 0.07 | 0.17 ± 0.03 |
| C17:1*n*7 | 0.19 ± 0.07 | 0.20 ± 0.04 | 0.20 ± 0.06 | 0.16 ± 0.03 |
| C18:0 | 14.21 ± 3.16 | 14.04 ± 2.11 | 14.04 ± 2.17 | 11.71 ± 2.68 |
| C18:1*n*9*c* + C18:1*n*9*t* | 45.58 ± 5.27 | 45.58 ± 4.34 | 45.58 ± 5.61$^{B}$ | 46.99 ± 7.32$^{B}$ |
| C18:2*n*6*c* | 8.16 ± 1.98$^{A}$ | 8.39 ± 2.04$^{A}$ | 8.39 ± 3.63$^{B}$ | 8.32 ± 3.94$^{B}$ |
| C18:2*n*6t | 0.00 ± 0.00 | 0.03 ± 0.01 | 0.03 ± 0.01 | 0.07 ± 0.02 |
| C18:3*n*6 (gamma) | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.03 ± 0.01 |
| C18:3*n*3 (alpha) | 0.45 ± 0.09 | 0.46 ± 0.08 | 0.46 ± 0.12 | 0.42 ± 0.09 |
| C20:0 | 0.24 ± 0.05 | 0.24 ± 0.05 | 0.24 ± 0.10 | 0.18 ± 0.07 |
| C20:1*n*15 | 0.05 ± 0.01 | 0.08 ± 0.02 | 0.08 ± 0.02 | 0.07 ± 0.03 |
| C20:1*n*9 | 1.28 ± 0.53$^{A}$ | 1.31 ± 0.24$^{A}$ | 1.31 ± 0.41 | 1.04 ± 0.19 |
| C20:2*n*6 | 0.50 ± 0.08 | 0.51 ± 0.09 | 0.51 ± 0.16 | 0.37 ± 0.08 |
| C20:3*n*6 | 0.06 ± 0.01 | 0.06 ± 0.01 | 0.06 ± 0.1b | 0.13 ± 0.04b |
| C20:4*n*6 | 0.10 ± 0.03 | 0.10 ± 0.01 | 0.10 ± 0.02$^{B}$ | 0.70 ± 0.15$^{B}$ |
| C20:3*n*3 | 0.13 ± 0.04 | 0.13 ± 0.05 | 0.13 ± 0.02 | 0.09 ± 0.02 |
| C20:5*n*3 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00$^{B}$ | 0.07 ± 0.02$^{B}$ |
| C22:1*n*9 | 0.03 ± 0.01 | 0.03 ± 0.01 | 0.03 ± 0.01 | 0.03 ± 0.01 |
| C22:2*n*6 | 0.03 ± 0.01$^{a}$ | 0.06 ± 0.01$^{a}$ | 0.06 ± 0.02$^{B}$ | 0.10 ± 0.03$^{B}$ |
| C24:0 | 0.00 ± 0.00 | 0.00 ± 0.00 | 0.00 ± 0.00$^{B}$ | 0.05 ± 0.01$^{B}$ |
| SFA | 41.11 ± 0.14$^{a}$ | 40.76 ± 0.14$^{a}$ | 37.99 ± 0.08 | 37.87 ± 0.50 |
| MUFA | 49.27 ± 0.19 | 49.32 ± 0.12 | 52.49 ± 0.08$^{B}$ | 51.70 ± 0.26$^{B}$ |
| PUFA | 9.43 ± 0.05$^{A}$ | 9.74 ± 0.02$^{A}$ | 9.35 ± 0.01$^{B}$ | 10.29 ± 0.25$^{B}$ |
| OMEGA 3 | 0.58 ± 0.01 | 0.59 ± 0.00 | 0.59 ± 0.00 | 0.57 ± 0.02 |
| OMEGA 6 | 8.85 ± 0.03$^{A}$ | 9.12 ± 0.02$^{A}$ | 8.76 ± 0.01$^{B}$ | 9.65 ± 0.23$^{B}$ |
| OMEGA 9 | 46.89 ± 0.14 | 46.92 ± 0.12 | 48.78 ± 0.10$^{B}$ | 48.06 ± 0.21$^{B}$ |
| *n*-6/*n*-3 | 15.22 ± 0.34$^{a}$ | 15.46 ± 0.03$^{a}$ | 14.85 ± 0.01$^{B}$ | 16.89 ± 0.22$^{B}$ |
| PUFA/SFA | 0.23 ± 0.00 | 0.24 ± 0.00 | 0.25 ± 0.00$^{B}$ | 0.27 ± 0.01$^{B}$ |

Means within a row with the same letters are significantly different; $^{A,B}$ $P < 0.01$; $^{a,b}$ $P < 0.05$

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of water in fresh meat at the level of 72.97% was demonstrated by Ivanović *et al.* (2013), and by Sales & Kotrba (2013) 70.5%. Fat content in the analysed wild boar muscle was low and amounted to 2.82%. A similar level of fat (2.54–3.13%) was determined by Amici *et al.* (2015) and Strazdina *et al.* (2013).

The brightness of frozen meat ($L^*$ = 40.25) expressed in the $L^*$ parameter was significantly lower compared to the brightness of fresh meat ($L^*$ = 44.5), which indicates darkening of meat under the influence of freezing (Table 1). There was also found a statistically significant decrease in the value of parameter $b^*$. The colour of the fresh meat of the tested boars was similar to the colour of boars in the studies of Marsico *et al*. (2007) ($L^*$ = 43.62) and Klimienė & Klimas (2010), who compared the colour of meat from wild boars living in nature, raised wild boars, pigs and hybrids. Their work showed that the wild boar meat was the darkest, the lightest was the pig meat ($L^*$ = 50.42) and the colour of the hybrid meat took intermediate values ($L^*$ = 47.85).

In frozen meat there was a slight increase in thermal drip compared to fresh meat from 25.21% to 26.18%. Similarly, the determined values of forced drip were higher in frozen meat (6.74 $cm^2$) than in fresh meat (6.51 $cm^2$). The average hardness of cycle 1 of frozen meat in this work was lower than in fresh meat and amounted to 104.46 N. The elasticity of frozen meat increased significantly from 3.27 mm to 4.86 millimeters. Of the remaining texture parameters, the gumminess and chewiness in meat frozen for 2 months were better than in fresh meat.

The profile of fatty acids in fat contained in fresh and frozen muscles *M. longissimus dorsi* of wild boar and in back fat is presented in Table 2. The profile of fatty acids of wild boar meat is similar to the acidic profile of back fat. Freezing more frequently caused significant changes in the case of fatty acids content in fat of the longest back muscle than in fat of back fat.

The highest content of saturated fatty acids was found in the case of C16 (palimitic acid) in back fat –24.69% and in fat of *M. longissimus dorsi* –24.77%. The second saturated fatty acid in terms of content was C18 (stearic acid) (14.21 and 14.04%). These results were similar to the results achieved by Razmaite *et al.* (2012) who determined content of C16 in intramuscular fat at the level of 23.63% in female specimens and 25% in male specimens. In subcutaneous fat it was 25.31 and 26.7%, respectively. Russo *et al.* (2017) determined the content of this acid at the level of 26.35% in *M. longissimus dorsi* in young wild boars (6–8 months), and in older ones (10–14 months) 22.29%. However, the content of C18 was found at the level of 14.96–15.21%. Razmaite *et al.* (2012) found the content in intramuscular fat at the level of 10.62 (female gender) and 11.28% (male gender), and in subcutaneous fat 13.2 and 14.85% respectively.

The dominant monounsaturated acid was C18:1 (oleic acid), and its content was 45.58% in both back fat and muscle fat, while the content of C18:2n6c (linoleic acid) was 8.16 and 8.39% respectively. High levels of oleic acid in wild boars can be caused by high intake of acorns (Dannenberger *et al*. 2013). In the work by Razmaite *et al.* (2012), the content of C18:1 in intramuscular fat was 39.29–40.13% and in subcutaneous fat 41.73–43.14%. Russo *et al.* (2017) found a lower content of this fatty acid at the level of 30.33–35.13%.

The percentage of saturated fatty acids (SFA) in wild boar meat (37.91%) was lower than in back fat (41%), while the share of monounsaturated fatty acids (MUFA) was higher in loin (52.85% compared to 49,43%). A higher proportion of OMEGA 9 fatty acids were also found in loin.

Russo *et al*. (2017) determined the content of saturated acids in young wild boars aged 6–8 months at the level of 44.72% and in older by 10–14 months 40.10%. They found a clear variation in the SFA content depending on the month of hunting; in wild boars hunted in October and November there were 40.6 and 39.61% SFA, and in animals hunted in December and January 45.01 and 44.42%. Quaresma *et al*. (2011) in adult boars hunted in February determined SFA content in meat at the level of 34.2–34.7% and in young boars 33.3%. A similar content of SFA (33.1%) was found by Valencak *et al*. (2015).

## CONCLUSIONS

Freezing storage of wild boar meat for a period of two months significantly increased the elasticity value and the colour of the meat as indicated by the decrease in $L^*$ and $b^*$ values. In frozen meat there slightly increased thermal drip and forced drip. The changes in the fatty acid profile under the effect of freezing were found more often in fat from muscle *M. longissimus dorsi* than in back fat of wild boar. In conclusion, it should be noted that freezing storage

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in a short time does not affect negatively the quality of frozen meat.

## References


Amici A., Cifuni G.F., Conto M., Esposito L., Failla S. (2015): Hunting area affects chemical and physical characteristics and fatty acid composition of wild boar (*Sus scrofa*) meat. Rendiconti Lincei. Scienze Fisiche e Naturali, 26: 527–534.

Borilova G., Hulankova R., Svobodova I., Jezek F., Hutarova Z., Tesarova S., Vecerek V., Steinhauserova I. (2015): Sensory and microbiological parameters of stored wild boar meat. Procedia Food Science, 5: 10–13.

Cifuni G.F., Amici A., Contò M., Viola P., Failla S. (2014): Effects of the hunting method on meat quality from fallow deer and wild boar and preliminary studies for predicting lipid oxidation using visible reflectance spectra. European Journal of Wildlife Research, 60: 519–526.

Dannenberger D., Nuernberg G., Nuernberg K., Hagemann E. (2013): The effects of gender, age and region on macro- and micronutrient contents and fatty acid profiles in the muscles of roe deer and wild boar in Mecklenburg-Western Pomerania (Germany). Meat Science, 94: 39–46.

Daszkiewicz T., Hnatyk N., Dąbrowski D., Janiszewski P., Gugołek A., Kubiak D., Śmiecińska W.K.R., Koba-Kowalczyk M. (2015): A comparison of the quality of the *Longissimus lumborum* muscle from wild and farm-raised fallow deer (*Dama dama* L.). Small Ruminant Research, 129: 77–83.

Górecka J., Szmańko T., Hyla N., Juszczak M. (2012): Comparing meat structure of wild boars and domestic pigs stored at near to cryoscopic temperature or in a frozen state. ŻYWNOŚĆ. Nauka. Technologia. Jakość, 81: 143–160. (in Polish).

Grau R., Hamm. R. (1953): Eine einfache Methode zur Bestimmung des Wasserbindung in Muskel. Naturwissenschaften, 40: 29–30.

Ivanović S.D., Stojanović Z.M., Popov-Raljic J.V., Baltić M.Ž., Pisinov B.P., Nešić K.D. (2013): Meat quality characteristics of Duroc × Yorkshire, Duroc × Yorkshire × wild boar and wild boar. Hemijska Iindustrija, 67: 999–1006.

Joumard-Cubizolles L., Chung-Yung Lee J., Vigor C., Leung H. H., Bertrand-Michel J., Galano J. M., Mazur A., Durand T., Gladine C. (2017): Insight into the contribution of isoprostanoids to the health effects of omega 3 PUFAs. Prostaglandins and Other Lipid Mediators, 133: 111–122.

Kasprzyk A. (2015): A comparison of chemical and physical parameters of musculus longissimus dorsi from wild boars and pigs. Annales UMCS: Sec EE Zootechnica, XXXIII(1): 1–9 (in Polish).

Kasprzyk A., Stasiak A., Babicz M. (2010): Meat quality and ultrastructure of muscle tissue from fatteners of Wild Boar, Pulawska and its crossbreed Pulawska × (Hamshire × Wild Boar). Archiv Tierzucht, 53: 184–193.

Kiyabu G.Y., Inoue M., Sait E., Abe S.K., Sawada N., Ishihara J., Iwasaki M., Yamaji T., Shimazu T., Sasazuki S., Shibuya K., Tsugane S. (2015): Fish, *n*23 polyunsaturated fatty acids and *n*26 polyunsaturated fatty acids intake and breast cancer risk: The Japan Public Health Center-based prospective study. International Journal of Cancer, 137: 2915–2926.

Klimienė A., Klimas R. (2010): The influence of the wild boar on the biological and performance traits of domestic pigs. Polish Journal of Natural Sciences, 25: 123–131.

Marchioli R., Levantesi G. (2013): *n*-3 PUFAs in cardiovascular disease. International Journal of Cardiology, 170: 33–38.

Marsico G., Rasulo A., Dimatteo S., Tarricone S., Pinto F., Ragni M. (2007): Pig, F1(wild boar × pig) and wild boar meat quality. Italian Journal of Animal Science, 6: 701–703.

Pohja M.S., Ninivaara F.P. (1957): Die Bestimung der Wasserbindung des Fleisches mittle der Konstantdruckmethode. Fleischwirtschaft, 9: 193–194.

Quaresma M.A.G., Alves S.P., Trigo-Rodrigues I., Pereira-Silva R., Santos N., Lemos J.P.C., Barreto A.S., Bessa R.J.B (2011): Nutritional evaluation of the lipid fraction of feral wild boar (*Sus scrofa scrofa*) meat. Meat Science, 89: 457–461.

Razmaitė V., Švirmickas G.J., Šiukščius A. (2012): Effect of weight, sex and hunting period on fatty acid composition of intramuscular and subcutaneous fat from wild boar. Italian Journal of Animal Science, 11: 174–179.

Russo C., Balloni S., Altomonte I., Martini M., Nuvoloni R., Cecchi F., Pedonese F., Salari F., da Silva A.M.S.T.B., Profumo A. (2017): Fatty acid and microbiological profile of the meat (longissimus dorsi muscle) of wild boar (*Sus scropha scropha*) hunted in Tuscany. Italian Journal of Animal Science, 16: 1–8.

Sales J. Kotrba R. (2013): Meat from wild boar (*Sus scrofa* L.): A review. Meat Science, 94: 187–201.

Shantakumari N., Eldeeb R.A., Ibrahim S.A., Sreedharan J., Otoum S. (2014): Effect of PUFA on patients with hypertension: A hospital based study. Indian Heart Journal, 66: 408–414.

Strazdina V., Jemeljanovs A., Šterna V. (2012): Fatty acids composition of elk, deer, roe deer and wild boar meat hunted in Latvia. International Journal of Animal and Veterinary Sciences, 6: 765–768.

Strazdina V., Jemeljanovs A., Šterna V. (2013): Nutrition value of wild animal meat. Proceedings of the Latvian Academy of Sciences. Section B, 67: 373–377.

https://doi.org/10.17221/62/2018-CJFS

Strazdina V., Jemeljanovs A., Šterna V., Ikauniece D. (2014): Nutritional characteristics of wild boar meat hunted in Latvia. Foodbalt, 53: 32–36.

Valencak T.G., Gamsjäger L., Ohrnberger S., Culbert N.J., Ruf T. (2015): Healthy n-6/n-3 fatty acid composition from five European game meat species remains after cooking. BMC Research Notes, 8(273): 1–6.

Walczak Z. (1959). Laboratory method for determining the content of jelly in canned meat. Roczniki Nauk Rolniczych, 74-B-4: 619. (in Polish)

Wood J.D., Enser M., Fisher A.V., Nute G.R., Sheard P.R., Richardson R.I., Hughes S.I., Whittington F.M. (2008): Fat deposition, fatty acid composition and meat quality: A review. Meat Science, 78: 343–358.

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