Fatty acid profile of meat (*Longissimus lumborum*) from female roe deer (*Capreolus capreolus* L.) and red deer (*Cervus elaphus* L.)

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**ABSTRACT**

The aim of this study was to compare the fatty acid profile of intramuscular fat (IMF) in female roe deer (*Capreolus capreolus* L.) and red deer (*Cervus elaphus* L.) living in the wild. The experimental materials comprised samples of the *Longissimus lumborum* (LL) muscle collected from 20 carcasses of does aged 3–5 years and 15 carcasses of hinds aged 4–6 years. All animals were hunter-harvested in the forests of North-Eastern Poland. The IMF of does had considerably higher concentrations of monounsaturated and polyunsaturated fatty acids. Therefore, it was characterized by more desirable values of quality parameters, and provided more health benefits. The observed differences in the fatty acid composition of IMF between does and hinds are important in view of both the nutritional value of meat and its susceptibility to lipid oxidation and rancidification.

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**Introduction**

Research shows that the quantity and quality of dietary fat are correlated with the risk of cardiovascular diseases.[1] A study conducted in the 1950s revealed that the consumption of large amounts of saturated fatty acids (SFAs) and cholesterol increases serum cholesterol levels.[2] According to the current nutritional guidelines, dietary fat intake should be reduced. This applies in particular to animal fats whose fatty acid profile is characterized by a high proportion of SFAs.[3]

According to the Dietary Guidelines for Americans 2015–2020, SFAs intake should be limited to less than 10% of total daily calories.[4] SFAs should be replaced with monounsaturated fatty acids (MUFAs), in particular polyunsaturated fatty acids (PUFAs).[1] Wood et al.[5] demonstrated that the dietary PUFAs to SFAs (P/S) ratio should not be lower than 0.4. However, an adequate intake of dietary PUFAs is equally important as the n-6/n-3 PUFAs balance (in particular the ratio of linolenic acid to alpha-linolenic acid) because the former increase the risk of coronary heart disease.[6] Therefore, the n-6/n-3 PUFAs ratio is an indicator of both the nutritional value of fat and its potential health implications, and it should be related to the P/S ratio. According to the UK Department of Health, the P/S ratio should not be lower than 0.1, and the n-6/n-3 PUFAs ratio should be below 4.[7] In the traditional Mediterranean diet, which is believed to contribute to preventing cardiovascular disease, the recommended n-6/n-3 PUFAs ratio is 1–2:1.[8] In the modern Western diet, the n-6/n-3 PUFAs ratio ranges from 10:1 to 20:1.[9]

Due to among others its undesirable fatty acid profile, red meat is one of the food products associated with health problems.[10] However, the opponents of this radical opinion claim that it is imprecise and does not apply to lean meat which is a source of ingredients essential for healthy bodily function such as protein, iron, zinc, selenium and B vitamins.[11,12] Wild game meat is a valuable red meat product characterized by low fat content.[13,14] For instance, the intramuscular fat
IMF content of meat from free-living cervids in Europe is usually below 1%. The IMF of wild animals has a desirable fatty acid profile, including healthy P/S and n-6/n-3 PUFA ratios. However, it should be noted that the quality of wild game meat may vary widely depending on, among other factors, animal species. The nature and scope of these variations are important considerations for both meat consumers and producers. The objective of this study was to compare the fatty acid profile of IMF in female roe deer (Capreolus capreolus L.) and red deer (Cervus elaphus L.) (does and hinds, respectively) living in the wild.

Materials and methods

The experimental materials comprised samples of the Longissimus lumborum (LL) muscle collected in a meat processing plant from 20 carcasses of does aged 3–5 years and 15 carcasses of hinds aged 4–6 years. All animals were hunter-harvested in the forests of North-Eastern Poland during one hunting season, between October and January. The age of animals was estimated based on carcass conformation and the wear of mandibular premolars and molars. The carcasses were dressed within 48–54 h of harvest (the time of harvest was determined based on hunter harvest reports). The quality of skinned carcasses was evaluated. Carcasses with signs of bullet damage to the Longissimus dorsi (LD) muscle, carcasses contaminated with digesta due to digestive tract damage caused by a bullet or incorrect evisceration, incorrectly chilled carcasses (temperature not higher than 7°C in the geometric center of the leg), and carcasses where the pH value of the LD muscle exceeded 5.8 (measured behind the last rib) were discarded to eliminate dark, firm and dry (DFD) meat.

During carcass dressing, similarly sized meat (LL muscle) samples were cut out from the right LD muscle (behind the last rib). The samples were placed in polyethylene bags and were transported to the laboratory in isothermal containers with refrigerant packs. The samples were stored in a refrigerated cabinet at 4°C until analyzed within 72 h of harvest. Laboratory analyses were performed to determine the fatty acid profile of IMF.

Intramuscular fat was extracted by Soxhlet extraction with diethyl ether as the solvent in the Soxtec Avanti 2050 Auto System (FOSS Analytical, Hilleroed, Denmark). The fatty acid profile of IMF was determined by gas chromatography using a PU-4600 Unicam gas chromatograph (UNICAM, Cambridge, UK) with a flame ionization detector (FID) on a glass capillary column (length: 2.10 m, inner diameter: 4.0 mm); detector temperature - 250°C, injector temperature - 225°C, column temperature - 200°C, carrier gas - argon, carrier gas flow rate - 50 mL/min. Fatty acid methyl esters were extracted by the modified Peisker method. The results were processed statistically by one-way ANOVA with the use of STATISTICA ver. 12 software. The statistical significance of differences between mean values in groups was determined using the Bonferroni correction.

Results and discussion

Table 1 shows the percentage of SFAs in IMF extracted from the LL muscles of female roe deer and red deer. Differences were found in both the concentrations of individual SFAs and the total SFAs content of IMF between the analyzed species. Heptadecanoic acid (C17:0) and stearic acid (C18:0) had a higher (P ≤ 0.01) share of total SFAs in roe deer. The concentrations of miristic acid (C14:0), pentadecanoic acid (C15:0) and palmitic acid (C16:0) were higher (P ≤ 0.01) in the IMF of red deer. The IMF of hinds had also higher arachidic acid (C20:0) content, but the difference between means was smaller (P ≤ 0.05). Differences in the concentrations of individual SFAs in the IMF of does and hinds led to a significant (P ≤ 0.01) difference in the total SFAs content, which was higher (P ≤ 0.01) in hinds.

C16:0 and C18:0 are predominant SFAs in red meat, which was also observed in our study. C16:0 as well as lauric acid (C12:0) and C14:0 which were found in considerably lower amounts exert atherogenic effects. They inhibit the expression of the LDL (low-density lipoprotein) receptor gene, thus increasing LDL cholesterol synthesis and total cholesterol levels. It should be noted that...
the potential of C14:0 to raise total serum cholesterol is 4- to 6-fold higher than that of C16:0.\textsuperscript{[23]} C18:0 has no effect on total and LDL cholesterol concentrations, probably due to the rapid conversion of C18:0 into oleic acid (C18:1) in the body.\textsuperscript{[24,25]} In view of the above, the considerably lower content of hypercholesterolemic fatty acids (OFAs), mostly C14:0 and C16:0, and the higher content of C18:0 in the IMF of does, noted in this study, point to the greater health benefits of roe deer meat compared with red deer meat.

The SFAs profile of IMF in roe deer and red deer, determined in our study, corroborates the findings of Strazdina et al.\textsuperscript{[16]} who also reported higher concentrations of C17:0 and C18:0, and lower levels of C12:0, C14:0, C15:0, C16:0 and C24:0 in IMF from the LL muscle of roe deer compared with red deer. Higher concentrations of C17:0 and C18:0 and lower levels of C14:0 in IMF from the Longissimus thoracis et lumborum muscle were also observed in roe deer by Valencak et al.\textsuperscript{[7]} However, the cited authors found a substantially higher content of C16:0 in roe deer meat.

In the analyzed animal species, the concentrations of individual fatty acids in meat can be affected by various factors such as the animals’ gender and age, and muscle type. In a study of male and female farmed red deer, conducted by Purchas et al.\textsuperscript{[26]}, the content of C18:0 was higher in males. In contrast, Polak et al.\textsuperscript{[27]} reported a higher content of C18:0 in meat from wild female red deer. The content of C16:0 in red deer meat was higher in males in a study by Polak et al.\textsuperscript{[27]}, and in females in a study by Purchas et al.\textsuperscript{[26]} Cygan-Szczegielniak and Janicki\textsuperscript{[28]} analyzed the influence of sex on the fatty acid profile of IMF extracted from the LL muscle of roe deer, and reported higher concentrations of C14:0, C16:0 and total SFAs in females. In females, the levels of C14:0, C16:0, C17:0, C18:0 and total SFAs in IMF tended to increase with age. In males, no clear correlations were found between age and changes in the total SFAs content. The concentrations of SFAs in IMF were highest in the oldest animals (6–7 years of age), lowest in animals aged 4–5 years, and medium in the youngest males (2–3 years of age).

Razmaite et al.\textsuperscript{[29]} demonstrated that IMF extracted from various muscles (Deltoides, Cleidocipitalis, Intercostales interni, Tensor fascia e latae) of roe deer hunter-harvested in summer (June - September) had different SFAs content. The Longissimus dorsi muscle had the lowest concentrations of C14:0, C18:0, C20:0 and total SFAs.

Table 2 presents the percentage of UFAs in the IMF of female roe deer and red deer. The IMF of hinds had higher (P ≤ 0.01) concentrations of myristoleic acid (C14:1) and palmitoleic acid (C16:1). The IMF of does was characterized by higher (P ≤ 0.01) levels of C18:1 followed by arachidonic acid (C20:4), and tended to have higher concentrations of linoleic acid (C18:2) (P = 0.051) and linolenic acid (C18:3) (P = 0.060). Differences in the concentrations of individual UFAs in the IMF of does and hinds were reflected in differences between the average total content of MUFA, PUFA and UFAs, which was considerably higher in roe deer.

### Table 1. Percentage of saturated fatty acids in total fatty acids in intramuscular fat in the Longissimus lumborum muscle of female roe deer and red deer (arithmetic means ± SD).

| Fatty acid | Species | roe deer | red deer |
|-----------|---------|----------|----------|
| C 14:0    |         | 1.56 ± 0.39 | 6.02 ± 1.48 |
| C 15:0    |         | 0.35 ± 0.10 | 0.79 ± 0.16 |
| C 16:0    |         | 24.13 ± 1.33 | 32.90 ± 3.23 |
| C 17:0    |         | 1.26 ± 0.22 | 1.03 ± 0.17 |
| C 18:0    |         | 22.05 ± 1.16 | 17.36 ± 4.16 |
| C 20:0    |         | 0.18 ± 0.04 | 0.25 ± 0.12 |
| SFAs      |         | 49.53 ± 2.22 | 58.34 ± 4.63 |

SFAs - saturated fatty acids.
SFAs = C 14:0 + C 15:0 + C 16:0 + C 17:0 + C 18:0 + C 20:0.
\textsuperscript{a}Values within a row with different superscript uppercase letters are significantly different at P ≤ 0.01.
\textsuperscript{b}Values within a row with different superscript lowercase letters are significantly different at P ≤ 0.05.
The fatty acids released during fat digestion in the gastrointestinal tract of non-ruminants can be absorbed and incorporated into tissue lipids in unchanged form. In ruminants, free fatty acids such as PUFAs released in the presence of microbial lipases are toxic to the animals. Therefore, they undergo biohydrogenation by rumen bacteria to less toxic SFAs (mostly C18:0). As a result, lower amounts of PUFAs are absorbed from the gastrointestinal tract and incorporated into tissue lipids, including muscle tissues, in ruminants than in non-ruminants.

Meat from wild ruminants, including Cervidae, contains larger amounts of PUFAs than meat from domesticated ruminants such as cattle and sheep. Beyond doubt, this is related to diet composition. Wild ruminants eat only natural and unprocessed foods, including different plant species. They also choose “preferred foods” and avoid “non-preferred” foods. The differences in the fatty acid profile of meat from livestock and game animals may also result from different IMF content. According to De Smet et al., differences in fat content affect the fatty acid composition of meat regardless of animal species, breed or dietary factors. The concentrations of SFAs and MUFAs increase with increasing fat content at a faster rate than the levels of PUFAs. This leads to a decrease in relative PUFAs content, followed by a decrease in the P/S ratio. The above relationships are confirmed by the coefficients of correlation between IMF content vs. total SFAs, MUFAs and the P/S ratio in meat from livestock.

In a study by Strazdina et al., IMF extracted from the LL muscle of red deer, compared with roe deer, had higher concentrations of C18:2 and MUFAs: C14:1, C16:1, C24:1. The IMF of roe deer contained higher amounts of C18:1 and PUFAs: C20:3, C20:4, C20:5. Valencak et al. also demonstrated that the IMF of roe deer had higher levels of PUFAs such as C18:2, C20:4, C20:5 and C22:5, whereas the IMF of red deer had a considerably higher content of monounsaturated C16:1.

As already mentioned, the fatty acid composition of fat may vary across animal species depending on the animals’ gender and age, and muscle type. Polak et al. found that meat from hinds had a higher content of C18:1 and C18:2 in the groups of analyzed MUFAs and PUFAs, respectively. In a study by Purchas et al., gender had no significant effect on the PUFAs content of meat in red deer, but meat from stags tended to have higher concentrations of PUFAs. Razmaite et al. analyzed the percentage of UFAs in the IMF of roe deer depending on muscle type and found that MUFAs concentrations were highest in the Intercoales interni muscle and lowest in the Longissimus dorsi muscle. The IMF extracted from the latter muscle had the highest content of PUFAs, whereas the lowest PUFAs levels were noted in the Cleidocipitalis muscle. Cygan-

| Fatty acid | Species | roe deer | red deer |
|-----------|---------|----------|----------|
|           |         |         |          |
| C 14:1    |         | 0.15 ± 0.13 | 1.86 ± 0.69 |
| C 16:1    |         | 2.39 ± 0.46 | 9.23 ± 2.66 |
| C 17:1    |         | 0.37 ± 0.10 | 0.39 ± 0.12 |
| C 18:1    |         | 34.58 ± 3.94 | 20.13 ± 2.56 |
| C 18:2    |         | 8.27 ± 1.85 | 7.01 ± 1.79 |
| C 18:3    |         | 1.89 ± 0.57 | 1.49 ± 0.62 |
| C 20:1    |         | 0.34 ± 0.11 | 0.34 ± 0.18 |
| C 20:4    |         | 2.48 ± 0.57 | 1.19 ± 0.48 |
| MUFAs     |         | 37.83 ± 3.76 | 31.96 ± 4.43 |
| PUFAs     |         | 12.63 ± 2.85 | 9.70 ± 2.59 |
| UFAs      |         | 50.47 ± 2.22 | 41.65 ± 4.63 |

MUFAs - monounsaturated fatty acids, PUFAs - polyunsaturated fatty acids, UFAs - unsaturated fatty acids (MUFAs + PUFAs).
MUFAs = C 14:1 + C 16:1 + C 17:1 + C 18:1 + C 20:1.
PUFAs = C 18:2 + C 18:3 + C 20:4.

Values within a row with different superscript uppercase letters are significantly different at P ≤ 0.01.
Szczegielniak and Janicki\textsuperscript{[28]} analyzed the influence of sex on the concentrations of UFAs in the IMF of roe deer, and found that the IMF of males had a lower content of MUFAs and a higher content of PUFAs. In the cited study, the percentages of MUFAs and PUFAs (in particular C18:1 and C18:2) in the IMF of adult females (aged 2–3 and 4–5 years) varied widely. The concentrations of MUFAs were higher and the levels of PUFAs were lower than in the IMF of females at 6–7 months of age. The differences in the content of MUFAs and PUFAs in the IMF of males from various age groups were considerably smaller.

Table 3 presents indicators of the nutritional value and health benefits of IMF determined based on an analysis of the fatty acid profile of intramuscular fat in the \textit{Longissimus lumborum} muscle of female roe deer and red deer (arithmetic means ± SD).

| Item                        | Species                      |
|-----------------------------|------------------------------|
|                             | roe deer                     | red deer                     |
| UFA/SFA ratio               | 1.02 ± 0.09                  | 0.72 ± 0.14                  |
| MUFA/SFA ratio              | 0.77 ± 0.10                  | 0.56 ± 0.12                  |
| PUFA/SFA ratio              | 0.26 ± 0.06                  | 0.17 ± 0.05                  |
| DFAs                        | 72.52 ± 1.66                 | 59.01 ± 4.17                 |
| OFAs (SFAs – C18:0)         | 27.48 ± 1.66                 | 40.99 ± 4.17                 |
| DFA/OFAs ratio              | 2.65 ± 0.22                  | 1.47 ± 0.28                  |
| EFAs                        | 10.16 ± 2.34                 | 8.50 ± 2.35                  |
| Nutritional value\textsuperscript{a} | 23.49 ± 1.12              | 17.98 ± 4.20                 |

UFAs - unsaturated fatty acids (MUFAs + PUFAs), SFAs - saturated fatty acids, MUFAs - monounsaturated fatty acids, PUFAs - polyunsaturated fatty acids, DFAs - hypocholesterolemic fatty acids (UFAs + C18:0), OFAs - hypercholesterolemic fatty acids (SFAs – C18:0), EFAs - essential fatty acids (C18:2 + C18:3), \textsuperscript{a}(C18:0 + C18:1)/C16:0).

Values within a row with different superscript uppercase letters are significantly different at \(P \leq 0.01\).

Values within a row with different superscript lowercase letters are significantly different at \(P \leq 0.05\).

In the present study, the P/S ratio was lower than recommended (> 0.4) but higher than the typical value (approx. 0.1) in meat from ruminants.\textsuperscript{[5,36]} Similar values of the P/S ratio in roe deer and red deer meat (0.8 vs. 0.82 and 0.68, respectively) were reported by Strazdina et al.\textsuperscript{[16]} and Valencak et al.\textsuperscript{[7]}. In a study by Strazdina et al.\textsuperscript{[16]} the n-6/n-3 PUFAs ratio was higher in the IMF of red deer (2.75), and in a study by Valencak et al.\textsuperscript{[7]} - in the IMF of roe deer (2.65). Strazdina et al.\textsuperscript{[16]} compared the fatty acid profile of meat from elk, red deer, roe deer and wild boar and found that that wild boar meat had the most desirable fatty acid composition.

A higher content of UFAs, in particular PUFAs, in meat is desirable in view of its nutritional value and health-promoting properties, but the limited oxidative stability of PUFAs gives cause for concern. Autoxidation of PUFAs leads to undesirable changes in the aroma and taste of meat, and to the formation of toxic compounds and compounds that decrease the nutritional value of meat.\textsuperscript{[39]} Therefore, meat should be handled, stored and processed properly.

**Conclusion**

An analysis of IMF from the LL muscle of wild female roe deer and red deer revealed significant differences in its fatty acid profile. The IMF of does had considerably higher concentrations of MUFAs and PUFAs, it was characterized by more desirable values of quality parameters, and provided more health benefits. The observed differences in the fatty acid composition of IMF between does and hinds are important in view of both the nutritional value of meat and its susceptibility to lipid oxidation and rancidification.
References

[1] Briggs, M.A.; Petersen, K.S.; Kris-Etherton, P.M. Saturated Fatty Acids and Cardiovascular Disease: Replacements for Saturated Fat to Reduce Cardiovascular Risk. Healthcare. 2017, 5(2), 29. pii: E29. DOI: 10.3390/healthcare5020029.

[2] Keys, A.; Anderson, J.T.; Grande, F. Serum Cholesterol Response to Changes in the Diet: IV. Particular Saturated Fatty Acids in the Diet. Metabolism 1957, 14(7), 747–787. DOI: 10.1016/0026-0495(65)90001-6.

[3] Moloney, A.P.; Potential of Animal Nutrition to Decrease the Saturated Fatty Acids in Meat and Milk. Lipid Technology 2012, 24(9), 199–2003. DOI: 10.1002/lite.201200220.

[4] U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2015-2020 Dietary Guidelines for Americans. 8th Edition. December 2015. Retrieved from https://health.gov/dietaryguidelines/2015/guidelines/.

[5] Wood, J.D.; Richardson, R.I.; Nute, G.R.; Fisher, A.V.; Campo, M.M.; Kasapidou, E.; Sheard, P.R.; Enser, M. Effects of Fatty Acids on Meat Quality: A Review. Meat Science 2004, 66(1), 21–32. DOI: 10.1016/S0309-1740(03)00022-6.

[6] Szostak-Węgierek, D.; Kłosiewicz-Latoszek, Ł.; Szostak, W.B.; Cybulksa, B. The Role of Dietary Fats for Preventing Cardiovascular Disease. A Review. Roczniki Państwowego Zakładu Higieny Państwowy Zakład Higieny 2013, 64(4), 263–269.

[7] Valencak, T.G.; Gamsjäger, L.; Ohrenberger, S.; Culbert, N.J.; Ruf, T., Healthy N-6/N-3 Fatty Acid Composition from Five European Game Meat Species Remains after Cooking. BMC Research Notes 2015, 8, 273–278. DOI: 10.1186/s13104-015-1254-1.

[8] Simopoulos, A.P.; The Mediterranean Diets. What Is so Special about the Diet of Greece? the Scientific Evidence. The Journal of Nutrition 2001, 131(11Suppl.), 3065S–3073S. DOI: 10.1093/jn/131.11.3065S.

[9] Cordain, L.; Eaton, S.B.; Sebastian, A.; Mann, N.; Lindeberg, S.; Watkins, B.A.; O’Keefe, J.H.; Brand-Miller, J. Origins and Evolution of the Western Diet: Health Implications for the 21st Century. The American Journal of Clinical Nutrition 2005, 81(2), 341–354. DOI: 10.1093/ajcn/81.2.341.

[10] Givens, D.I.; Milk and Meat in Our Diet: Good or Bad for Health?. Animal 2010, 4(12), 1941–1952. DOI: 10.1017/S1751731110001503.

[11] McAfee, A.J.; McSorley, E.M.; Cuskey, G.J.; Moss, B.W.; Wallace, J.M.W.; Bonham, M.P.; Fearon, A.M. Red Meat Consumption: An Overview of the Risks and Benefits. Meat Science 2010, 84(1), 1–13. DOI: 10.1016/j.meatsci.2009.08.029.

[12] McNeill, S.H.; Inclusion of Red Meat in Healthful Dietary Patterns. Meat Science 2014, 98(3), 452–460. DOI: 10.1016/j.meatsci.2014.06.028.

[13] Florek, M.; Drozd, L. Bioactive Compounds in Deer Meat. Medycyna Weterynaryjna 2013, 69(9), 535–539.

[14] Nuernberg, K.; Nuernberg, G.; Dannenberger, D. Nutrient and Lipid Composition of Muscle in Wild Animals. Fleischwirtschaft 2009, 89, 99–102.

[15] Hoffman, L.C.; Wiklund, E. Game and Venison - Meat for the Modern Consumer. Meat Science 2010, 84(1), 197–208. DOI: 10.1016/j.meatsci.2006.04.005.

[16] Strazdina, V.; Jemeljanovs, A.; Sterna, V. Fatty Acids Composition of Elk, Deer, Roe Deer and Wild Boar Meat Hunted in Latvia. World Academy of Science, Engineering and Technology. International Journal of Animal and Veterinary Sciences 2012, 6(9), 765–768.

[17] AOAC. Official Methods of Analysis, 18th ed.; Association of Official Analytical Chemists: Arlington, VA, USA, 2010.

[18] Żegarska, Z.; Jaworski, Z.; Borejszo, Z. Evaluation of the Peisker Modified Method for Extracting Methyl Esters from Fatty Acids. Acta Academiae Agriculturae Ac Technicae Olstenensis. Technologia Alimentarum 1991, 24, 25–33.

[19] StatSoft, Inc. STATISTICA (Data Analysis Software System), Version 12; Tulsa, OK, USA, 2014. www.statsoft.com.

[20] Wyness, L.; Weichselbaum, E.; O’Connor, A.; Williams, E.B.; Benelam, B.; Riley, H.; Stanner, S. Red Meat in the Diet: An Update. Nutrition Bulletin 2011, 36, 34–77. DOI: 10.1111/j.1467-3010.2010.01871.x.

[21] Luz Fernandez, M.; West, K.L. Mechanisms by Which Dietary Fatty Acids Modulate Plasma Lipids. The Journal of Nutrition 2005, 135(9), 2075–2078. DOI: 10.1093/jn/135.9.2075.

[22] Mustad, V.A.; Ellsworth, J.L.; Cooper, A.D.; Etherton, T.D. Dietary Linoleic Acid Increases and Palmitic Acid Decreases Hepatic LDL Receptor Protein and mRNA Abundance in Young Pigs. Journal of Lipid Research 1996, 37(11), 2310–2323.

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[23] Mensink, R.P.; Katan, M.B. Effect of Dietary Fat Acids on Serum Lipids and Lipoproteins: A Meta-Analysis of 27 Trials. Arteriosclerosis Thrombosis and Vascular Biology 1992, 12(8), 911–919. DOI: 10.1161/01.ATV.12.8.911.

[24] Siri-Tarino, P.W.; Sun, Q.; Hu, F.B. Saturated Fat, Carbohydrate, and Cardiovascular Disease. The American Journal of Clinical Nutrition 2010, 91(3), 502–509. DOI: 10.3945/ajcn.2008.26285.

[25] Emken, E.A.; Metabolism of Dietary Stearic Acid Relative to Other Fatty Acids in Human Subjects. The American Journal of Clinical Nutrition 1994, 60(6Suppl.), 1023S–1028S. DOI: 10.1093/ajcn/60.6.1023S.

[26] Purchas, R.W.; Triumph, E.C.; Egelandslad, A. Quality Characteristics and Composition of the Longissimus Muscle in the Short-Loin from Male and Female Farmed Red Deer in New Zealand. Meat Science 2010, 86 (2), 505–510. DOI: 10.1016/j.meatsci.2010.05.043.

[27] Polak, T.; Rajar, A.; Gašperlin, L.; Žlender, B. Cholesterol Concentration and Fatty Acid Profile of Red Deer (Cervus Elaphus) Meat. Meat Science 2008, 80(3), 864–869. DOI: 10.1016/j.meatsci.2008.04.005.

[28] Cygan-Szczezcielski, D.; Janicki, B. Influence of Age and Sex on the CLA and Other Fatty Acids Content in Roe Deer Meat (Capreolus Capreolus L.). Folia Biologica (Krakow) 2011, 59(1–2), 19–24. DOI: 10.3409/fb59_1-2.19-24.

[29] Razmaité, V.; Šiukčiūnas, A.; Pileckas, V.; Švirmickas, G.J. Effect of Different Roe Deer Muscles on Fatty Acid Composition in Intramuscular Fat. Annals of Animal Science 2015, 15(3), 775–784. DOI: 10.1515/aos-2015-0012.

[30] Jenkins, T.C.; Wallace, R.J.; Moate, P.J.; Mosley, E.E. Board-Invited Review: Recent Advances in Biohydrogenation of Unsaturated Fatty Acids within the Rumen Microbial Ecosystem. Journal of Animal Science 2008, 86(2), 397–412. DOI: 10.2527/jas.2007-0588.

[31] Scollan, N.D.; Dannenberger, D.; Nuernberg, K.; Richardson, I.; MacKintosh, S.; Hocquette, J.F.; Moloney, A.P. Innovations in Beef Production Systems that Enhance the Nutritional and Health Value of Beef Lipids and Their Relationship with Meat Quality. Meat Science 2008, 80(4), 756–766. DOI: 10.1016/j.meatsci.2008.04.005.

[32] Scollan, N.; Hocquette, J.; Nuernberg, K.; Dannenberger, D.; Richardson, I.; Moloney, A.P. Effects of Different Roe Deer Muscles on Fatty Acid Composition in Intramuscular Fat. Annals of Animal Science 2015, 15(3), 775–784. DOI: 10.1515/aos-2015-0012.

[33] Storms, D.; Aubry, P.; Hamann, J.-L.; Said, S.; Fritz, H.; Saint-Andrieux, C.; Klein, F. Seasonal Variation in Diet Composition and Similarity of Sympatric Red Deer Cervus Elaphus and Roe Deer Capreolus Capreolus. Wildlife Biology 2008, 14(2), 237–250. DOI: 10.2981/0099-6396(2008)14[237SVICA]2.0.CO;2.

[34] De Smet, S.; Raes, K.; Demeyer, D. Meat Fatty Acid Composition as Affected by Fatness and Genetic Factors: A Review. Animal Research 2004, 53(2), 81–98. DOI: 10.1051/animres:2004003.

[35] Dinh, T.T.N.; Blanton, J.R., Jr; Riley, D.G.; Chase, C.C., Jr; Coleman, S.W.; Phillips, W.A.; Brooks, J.C.; Miller, M.F.; Thornpson, L.D. Intramuscular Fat and Fatty Acid Composition of Longissimus Muscle from Divergent Pure Breeds of Cattle. Journal of Animal Science 2010, 88(2), 756–766. DOI: 10.2527/jas.2009-1951.

[36] Jacyno, E.; Pietruszka, A.; Kawka, M.; Biel, W.; Kołodziej-Skalska, A. Phenotypic Correlations of Backfat Thickness with Meatiness Traits. Intramuscular Fat, Longissimus Muscle Cholesterol and Fatty Acid Composition in Pigs. South African Journal of Animal Science 2015, 45(2), 122–128. DOI: 10.4314/sajas.v45i2.2.

[37] Yousefi, A.R.; Kohram, H.; Shahrne, A.Z.; Nik-Khah, A.; Campbell, A.W. Comparison of the Meat Quality and Fatty Acid Composition of Traditional Fat-Tailed (Chall) and Tailed (Zel) Iranian Sheep Breeds. Meat Science 2012, 92(4), 417–422. DOI: 10.1016/j.meatsci.2012.05.004.

[38] Scollan, N.; Hocquette, J.; Nuernberg, K.; Dannenberger, D.; Richardson, I.; Moloney, A. Innovations in Beef Production Systems that Enhance the Nutritional and Health Value of Beef Lipids and Their Relationship with Meat Quality. Meat Science 2006, 74(1), 17–33. DOI: 10.1016/j.meatsci.2006.05.002.

[39] Papuc, C.; Goran, G.V.; Predescu, C.N.; Nicorescu, V. Mechanisms of Oxidative Processes in Meat and Toxicity Induced by Postprandial Degradation Products: A Review. Comprehensive Reviews in Food Science and Food Safety 2017, 16(6), 96–123. DOI: 10.1111/1541-4337.12298.