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Research article

NUTRITIONAL VALUE OF WILD-HARVESTED GAME MEAT OF FALLOW DEER (*DAMA DAMA*), RED DEER (*CERVUS ELAPHUS*), AND ROE DEER (*CAPREOLUS CAPREOLUS*)

Marija STARČEVIĆ[1*], Nataša GLAMOČLIJA[2], Branislav BALTIĆ[3], Milica GLIŠIĆ[4], Milica LAUDANOVIĆ[2], Milena KRSTIĆ[5], Marija BOŠKOVIĆ CABROL[4]

[1]Ministry of defense of Republic of Serbia, Veterinary Service Centre, Military Health Department, Belgrade, Serbia; [2]University of Belgrade, Faculty of Veterinary Medicine, Department of Nutrition and Botany, Belgrade, Serbia; [3]Institute of Meat Hygiene and Technology, Belgrade, Serbia; [4]University of Belgrade, Faculty of Veterinary Medicine, Department of Food Hygiene and Technology, Belgrade, Serbia; [5] University of Belgrade, Faculty of Veterinary Medicine, Department of General Education, Belgrade, Serbia.

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The study aimed to compare the chemical composition (proximate, mineral, fatty acid, and amino acid composition) and nutritional value of meat from three deer species (fallow deer, red deer, and roe deer). A total of eighteen male carcasses of three species were collected. Proximate composition of deer meat (*M. longissimus lumborum*) did not differ among the three deer species, while deer species affected the content of most minerals (Ca, P, Na, Mg, Fe, Mn, and Zn). In the present study analysis of the fatty acid profile of deer meat showed that the polyunsaturated fatty acid (PUFA) to saturated fatty acid ratio and n-6/n-3 PUFA ratio were, for all three deer species, within the recommended values. Furthermore, based on nutritional indexes (n-6/n-3 PUFA ratio, atherogenicity index, hypocholesterolaemic to hypercholesterolaemic fatty acid ratio, and nutrition value index), it is concluded that roe deer meat had the highest, while fallow deer meat had the lowest nutritive value. Although the content of certain essential amino acids (isoleucine and valine) was lower in fallow deer meat than in red deer and roe deer meat ($p \leq 0.05$), the ratio of essential to non-essential amino acids was higher in fallow deer than in the two other deer species ($p \leq 0.05$).

Keywords: Deer meat, proximate composition, mineral content, amino acid profile, fatty acid profile

*Corresponding author: e-mail: marijadok@gmail.com

INTRODUCTION

Production and consumption of game meat has increased in recent years [1], gaining growing popularity across Europe [2]. Concerning its nutritional profile, game meat has high contents of proteins, essential amino acids (AA), minerals, and vitamins, but a low content of fat, a favourable n-6 to n-3 polyunsaturated fatty acid (PUFA) ratio, and high levels of conjugated linoleic acid (CLA) [3]. Venison is low in cholesterol, rich in PUFA and iron, and offers appealing sensory qualities (flavour, aroma, and texture) compared to beef [4]. Nowadays, consumers are becoming increasingly interested in the safety and quality of meat. Moreover, game meat is generally considered a healthy option due to animals primarily feeding on pasture free of chemicals and medicines [5].

Since consumer concerns about the quality and overall wholesomeness of deer meat have risen significantly over the past decades, several authors have recently studied deer meat quality. Deer meat quality depends on many factors, such as species [3,6-8], sex [2,5,8-10], age [7,9,11], rearing system [2,12], diet [13,14], season [5,15,16], region [16], and muscle type [10,12,17].

Fallow deer and red deer are widely distributed deer species in different geographical areas of Europe, Asia, and North America [9,17], while roe deer is predominantly widespread in Europe [18]. Although meat quality of deer has been extensively investigated during the last two decades, to the best of our knowledge, there are insufficient data in the published literature that compare the chemical composition and nutritional value of the most common deer species in Europe. Therefore, the aim of this study was to assess the effect of deer species (fallow deer (*Dama dama*), red deer (*Cervus elaphus*), and roe deer (*Capreolus capreolus*)) on meat chemical composition (proximate composition, mineral content, fatty acid (FA) profile, and AA profile) and nutritional value of deer meat.

MATERIALS AND METHODS

Animals, hunting region, diet, and meat sampling

The experiment was performed in line with the legislations on animal welfare [19] and hunting procedures [20].

A total of eighteen male carcasses of three species (6 fallow deer (*Dama dama*), 6 red deer (*Cervus elaphus*), and 6 roe deer (*Capreolus capreolus*)) were collected during the hunting season in October of 2022. Animals were approximately between two and three years old and age was estimated by teeth eruption [21].

Free-living deer of the three species used in this study were hunted in the forests of the eastern part of Serbia, within the Zlot hunting area at latitude 44° 00' 21" N and longitude 21° 59' 05" E (from 400 to 1175 m above sea level). The animals in

the Zlot hunting area had access to 17,913.58 hectares of free roaming forest area, predominantly consisting of beech (*Fagus silvatica*), and partly of oak (*Quercus robur*), maple (*Acer campestre, Acer platanoides*) and hornbeam (*Carpinus betulus*). The ground vegetation consisted of blackberries (*Rubus fruticosus*), nettle (*Urtica dioica*), sweet woodruff (*Galium odoratum*), white wood-rush (*Luzula luzuloides*), coralroot bittercress (*Cardamine bulbifera*), ground-ivy (*Glechoma hyrsuta*), hart's tongue (*Phyllitis scolopendrium*), and perennial grass (*Festuca drymeja*). Considering the differences in deer species (fallow deer, red deer, and roe deer), three experimental groups were formed, each containing 6 carcasses.

After shooting, the animals were immediately bled out and then eviscerated within 1 h. At 24 h post mortem, meat samples (*M. longissimus lumborum*) were taken from each carcass, packed in polyethylene bags, and kept at -18°C until analyses of proximate composition, FA and AA profiles, and mineral contents were performed.

Proximate composition of meat

The day before analysis of proximate composition, content of minerals, FA and AA profiles, meat samples were defrosted overnight at 4°C. The content of dry matter [22], fat [23], protein [24], and ash [25] in meat samples was determined using official methods.

Determination of minerals

Content of P was determined according to the ISO 13730 procedure [26] using spectrophotometric measurements performed with a Halo DB-20/dB-20S (Dynamica, UK). Content of other minerals (Ca, Na, Mg, K, Fe, Cu, Mn, and Zn) was determined according to the method previously described by Bošković Cabrol et al. [27]. Before analysis of Se content, meat samples were mineralized using microwave-assisted mineralization with a digestion mixture of concentrated HNO_3 and H_2O_2 (4:1) within a closed-vessel heating system (MILESTONE TC, Sorisole, Italy). Se was subsequently determined by hydride generation atomic absorption spectrophotometry (HGAAS) (THERMO SOLAAR S4 VP90 system, Thermo Fisher Scientific, Waltham, MA, USA).

Fatty acid profile of meat

FA were determined according to a method previously described by Spirić et al. [28] and Glišić et al. [29]. The level of FA was expressed as a percentage (%) of the total identified FA (lauric acid (C12:0), myristic acid (C14:0), pentadecanoic acid (C15:0), palmitic acid (C16:0), margaric acid (C17:0), stearic acid (C18:0), arachidic acid (C20:0), docosanoic acid (C22:0), lignoceric acid (C24:0), myristoleic acid (C14:1), cis-10-pentadecenoic acid (C15:1), palmitoleic acid (C16:1), cis-10-heptadecanoic acid (C17:1), oleic acid (C18:1n9c), cis-11-eicosenoic acid (C20:1n9), erucic acid (C22:1

n9), nervonic acid (C24:1), linoleic acid (C18:2n6c), gamma-linolenic acid (C18:3-n6), cis-13,16-docosapentaenoic acid (C22:5), cis-8,11,14-eicosatrienoic acid (C20:3-n6), arachidonic acid (C20:4-n6), docosadienoic acid (C22:2-n6), docosatetraenoic acid (C22:4-n6), alpha-linolenic acid (C18:3-n3), cis-11,14,17-eicosatrienoic acid (C20:3-n3), eicosapentaenoic acid (C20:5-n3), docosapentaenoic acid (C22:5-n3), docosahexaenoic acid (C22:6-n3)).

Determination of atherogenicity index (AI), thrombogenicity index (TI), hypocholesterolaemic to hypercholesterolaemic fatty acid ratio (H/H), and nutrition value index (NVI)

The atherogenicity index (AI) and the thrombogenicity index (TI) were calculated according to the equations proposed by Ulbricht and Southgate [30]. The hypocholesterolemic to hypercholesterolemic fatty acid ratio (H/H) was calculated according to Paszczyk et al. [31]. The nutrition value index (NVI) was calculated according to Chen et al. [32].

$$AI = (C12{:}0 + (4 \times C14{:}0) + C16{:}0) / (\sum n\text{-}3\ PUFA + \sum n\text{-}6\ PUFA + \sum MUFA)$$

$$TI = (C14{:}0 + C16{:}0 + C18{:}0) / (0.5 \times \sum MUFA + 0.5 \times \sum n\text{-}6\ PUFA + 3 \times \sum n\text{-}3\ PUFA + \sum n\text{-}3\ PUFA / \sum n\text{-}6\ PUFA)$$

$$H/H = (C18{:}1n\text{-}9c + C18{:}2n\text{-}6 + C18{:}3n\text{-}3) / (C12{:}0 + C14{:}0 + C16{:}0)$$

$$NVI = (C18{:}0 + C18{:}1n9) / (C16{:}0)$$

Amino acid analysis

The content of AAs (arginine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, valine, alanine, aspartic acid, cysteine, glutamic acid, glycine, proline, serine, tyrosine) was determined by the method described by Bošković Cabrol et al. [27].

Statistical analysis

Statistical analysis of the results was elaborated using software GraphPad Prism version 6.00 for Windows (GraphPad Software, San Diego, CA, USA, www.graphpad.com). All parameters were described by means and standard error of means (SEM). One-way ANOVA with Tukey's post-test was performed to assess the effect of game species (fallow deer, red deer, and roe deer) on proximate composition, mineral content, FA, and AA profile of deer meat. Values of $p \leq 0.05$ were considered significant.

RESULTS

Proximate composition of deer meat

The meat proximate composition of three game species (fallow deer, red deer, and roe deer) is presented in Table 1. In deer meat, the protein content ranged from 22.72 to 22.94 g/100 g, while fat content ranged from 1.43 to 1.50 g/100 g. The proximate composition of deer meat did not differ among species ($p>0.05$).

Table 1. The effect of game species (fallow deer, red deer, and roe deer) on chemical composition of deer meat (*M. longissimus lumborum*) (n=6)

Parameters (g/100 g muscle)	Fallow deer	Red deer	Roe deer	SEM	p value
Dry matter	25.54	25.23	25.35	0.19	0.181
Protein	22.94	22.72	22.79	0.18	0.350
Fat	1.50	1.43	1.46	0.04	0.161
Ash	1.10	1.11	1.10	0.02	0.718

Data are means and standard error of means (SEM).

Mineral content of deer meat

The effect of game species (fallow deer, red deer, and roe deer) on the mineral content of meat is presented in Table 2. The most abundant macrominerals were potassium and phosphorus that ranged from 4255 to 4450 mg/kg and from 1915 to 2250 mg/kg, respectively. In deer meat, Fe (from 19.50 to 22.00 mg/kg) and Zn (from 13.52 to 15.18 mg/kg) predominated among the microminerals. Species significantly affected the contents of Ca, P, Na, Mg, Fe, Mn, and Zn ($p\leq0.05$), while it did not affect the contents of K, Cu, or Se in deer meat ($p>0.05$). Roe deer meat had higher contents of P (+17.49% and +7.50%; $p\leq 0.001$), Na (+45.26% and +37.59%; $p\leq 0.001$), and Mg (+23.28% and +21.19%; $p\leq 0.001$), and lower content of Ca (-50.29% and – 53.00%; $p\leq 0.001$) compared to fallow deer and red deer meat. Red dear meat had higher P content than fallow deer meat. The content of Fe was higher in fallow deer meat than in red deer and roe deer meat (+9.07% and +12.82%; $p=0.0081$). Higher content of Mn (+22.22%; $p=0.0009$) and lower content of Zn (-10.94%; $p=0.0011$) was detected in fallow deer than in roe deer meat.

Table 2. The effect of game species (fallow deer, red deer, and roe deer) on mineral content of deer meat (*M. longissimus lumborum*) (n=6)

Parameters (mg/kg)	Fallow deer	Red deer	Roe deer	SEM	p value
Macrominerals					
Calcium (Ca)	141.2^{A}	149.3^{A}	70.17^{B}	4.09	≤ 0.001
Phosphorus (P)	1915^{A}	2093^{B}	2250^{C}	65.03	≤ 0.001
Sodium (Na)	950.0^{A}	1003^{A}	1380^{B}	32.63	≤ 0.001
Potassium (K)	4255	4345	4450	191.35	0.476
Magnesium (Mg)	192.5^{A}	195.8^{A}	237.3^{B}	6.88	≤ 0.001
Microminerals					
Iron (Fe)	22.00^{A}	20.17^{B}	19.50^{B}	0.86	0.008
Copper (Cu)	1.27	1.27	1.30	0.12	0.931
Manganese (Mn)	0.44^{A}	0.40^{AB}	0.36^{B}	0.02	0.001
Zinc (Zn)	13.52^{A}	14.38^{AB}	15.18^{B}	0.43	0.001
Selenium (Se)	0.13	0.13	0.14	0.003	0.077

Data are presented as means and standard error of means (SEM); **A, B, C** – Means within the same row with different superscripts differ significantly (p≤ 0.05).

Fatty acid composition of deer meat

The FA profiles of the *M. longissimus lumborum* from fallow deer, red deer, and roe deer are shown in Table 3. Species significantly affected the content of FA in deer meat (p≤ 0.05), except for eicosadienoic acid (C20:2-n6) (p=0.1689). The total SFA was the highest in fallow deer (43.68%) and the lowest in red deer meat (39.09%; p≤ 0.001). Significantly higher levels of lauric (C12:0) (+88.89% and +88.89%; p≤ 0.001), myristic (C14:0) (+26.54% and +149.24%; p≤ 0.001), and margaric (C17:0) (+51.82% and +27.48%; p≤ 0.001) FAs were determined in fallow deer than in red deer and row deer meat. The content of C17:0 and C22:0 was the lowest in red deer, while the content of C18:0, C20:0, and C24:0 was the highest in roe deer.

Table 3. The effect of game species (fallow deer, red deer, and roe deer) on fatty acid profile and nutritive indicators of deer meat (*M. longissimus lumborum*) (n=6)

Parameters (g/100 g muscle)	Fallow deer	Red deer	Roe deer	SEM	p value
Fatty acids					
C12:0	0.17^{A}	0.09^{B}	0.09^{B}	0.01	≤ 0.001
C14:0	3.29^{A}	2.60^{B}	1.32^{C}	0.09	≤ 0.001
C15:0	0.47^{A}	0.41^{AB}	0.40^{B}	0.03	0.031
C16:0	21.03^{A}	19.46^{B}	20.02^{AB}	0.68	0.039
C17:0	1.67^{A}	1.10^{B}	1.31^{C}	0.05	≤ 0.001
C18:0	16.75^{A}	15.15^{B}	18.79^{C}	0.60	≤ 0.001
C20:0	0.08^{A}	0.06^{B}	0.11^{C}	0.01	≤ 0.001
C22:0	0.12^{A}	0.15^{B}	0.04^{C}	0.01	≤ 0.001
C24:0	0.11^{A}	0.08^{B}	0.21^{C}	0.01	≤ 0.001
∑SFA	43.68^{A}	39.09^{B}	42.29^{C}	0.60	≤ 0.001
C14:1	2.84^{A}	1.63^{B}	0.25^{C}	0.05	≤ 0.001
C15:1	2.35^{A}	0.06^{B}	0.05^{B}	0.15	≤ 0.001
C16:1	3.62^{A}	6.15^{B}	2.10^{C}	0.14	≤ 0.001
C17:1	0.68^{A}	0.06^{B}	0.34^{C}	0.03	≤ 0.001
C18:1	19.09^{A}	22.76^{B}	30.22^{C}	0.50	≤ 0.001
C20:1	0.07^{A}	0.07^{A}	1.40^{B}	0.02	≤0.001
C22:1	0.55^{A}	0.06^{B}	0.04^{B}	0.01	≤ 0.001
C24:1	0.24^{A}	0.22^{A}	0.13^{B}	0.01	≤ 0.001
ΣMUFA	29.20^{A}	31.00^{B}	34.59^{C}	0.50	≤ 0.001
C18:2-n6	10.43^{A}	11.95^{B}	8.07^{C}	0.46	≤ 0.001
C18:3-n6	0.10^{A}	0.15^{B}	0.07^{C}	0.01	≤ 0.001
C20:2-n6	0.09	0.09	0.08	0.01	0.169
C20:3-n6	0.54^{A}	0.43^{B}	0.29^{C}	0.04	≤ 0.001
C20:4-n6	5.50^{A}	6.01^{B}	4.07^{C}	0.24	≤ 0.001
C22:2-n6	0.10^{A}	0.24^{B}	0.04^{C}	0.01	≤ 0.001
C22:4-n6	0.56^{A}	0.31^{B}	0.07^{C}	0.02	≤ 0.001
∑n-6 PUFA	17.32^{A}	19.18^{B}	12.69^{C}	0.52	≤ 0.001
C18:3-n3	2.19^{A}	3.11^{B}	3.82^{C}	0.07	≤ 0.001
C20:3-n3	0.27^{A}	0.36^{B}	0.05^{C}	0.02	≤ 0.001
C20:5-n3	1.68^{A}	2.09^{B}	1.95^{B}	0.08	≤ 0.001
C22:5-n3	1.67^{A}	2.07^{B}	1.83^{C}	0.06	≤ 0.001
C22:6-n3	2.20^{A}	0.86^{B}	0.30^{C}	0.06	≤ 0.001
∑n-3 PUFA	8.01^{A}	8.49^{B}	7.95^{A}	0.19	≤ 0.001
CLA	1.79^{A}	2.24^{B}	2.48^{B}	0.15	≤ 0.001
∑PUFA	27.12^{A}	29.91^{B}	23.12^{C}	0.61	≤ 0.001

Continuation of the Table 3..

EPA+DHA	3.88^{A}	2.96^{B}	2.25^{B}	0.11	≤ 0.001
∑n-6 PUFA/∑n-3 PUFA	2.16^{A}	2.26^{A}	1.60^{B}	0.07	≤ 0.001
∑UFA	56.3^{A}	60.92^{B}	57.71^{C}	0.60	≤ 0.001
UFA/SFA	1.29^{A}	1.56^{B}	1.36^{A}	0.04	≤ 0.001
MUFA/SFA	0.67^{A}	0.79^{B}	0.82^{B}	0.02	≤ 0.001
PUFA/SFA	0.62^{A}	0.77^{B}	0.55^{C}	0.02	≤ 0.001
AI	0.63^{A}	0.51^{B}	0.46^{C}	0.02	≤ 0.001
TI	0.84^{A}	0.71^{B}	0.81^{A}	0.02	≤ 0.001
H/H	1.28^{A}	1.71^{B}	1.97^{C}	0.07	≤ 0.001
NVI	1.69^{A}	1.96^{B}	2.46^{C}	0.10	≤ 0.001

Data are presented as means and standard error of means (SEM); **SFA** – saturated fatty acids; **MUFA** – monounsaturated fatty acids; **PUFA** – polyunsaturated fatty acids; **CLA** – conjugated linoleic acid; **EPA+DHA** – sum of eicosapentaenoic (C20:5n-3) and docosahexaenoic (C22:6n-3) fatty acids; **UFA** – unsaturated fatty acids; **AI** = atherogenicity index; **TI** = thrombogenicity index; **H/H** = hypocholesterolemic to hypercholesterolemic fatty acid ratio; **NVI** = Nutrition Value Index; **A, B, C** – Means within the same row with different superscripts differ significantly ($p \leq 0.05$).

The total MUFA was the highest in roe deer meat (34.59%) and the lowest in fallow deer meat (29.20%) (p≤ 0.001). The highest proportions of oleic (C18:1) (+58.30% and 32.78%; p≤ 0.001) and eicosenoic (C20:1) (+1900% and 1900%; p≤ 0.001) FAs were found in roe deer meat compared with proportions in fallow deer and red deer meat.

The highest percentage of PUFA were determined in red deer meat for linoleic (LA) (C18:2-n6) (+14.57% and +48.08%; p≤ 0.001), gamma-linolenic (C18:3-n6) (+50.00% and +114.29%; p≤ 0.001), arachidonic (C20:4-n6) (+9.27% and 47.67%; p≤ 0.001), docosadienoic (C22:2-n6) (+140.00% and +500.00%; p≤ 0.001), cis-11,14,17-eicosatrienoic acid (C20:3-n3) (+33.33% and 620.00%; p≤ 0.001), and docosapentaenoic (C22:5-n3) acids (+23.95% and +13.11%; p≤ 0.001), rather than in fallow deer and roe deer meat. The highest levels of cis-8,11,14-eicosatrienoic acid (C20:3-n6) (+25.58% and +86.21%; p≤ 0.001), docosatetraenoic (C22:4-n6) (+80.65% and +700.00%; p≤ 0.001), and docosahexaenoic (C22:6-n3) (+155.81% and +633.33%; p≤ 0.001), and the lowest levels of alpha-linolenic (ALA) (C18:3-n3) (-29.58% and – 42.67%; p≤ 0.001), eicosapentaenoic (C20:5-n3) (-19.62% and – 13.85%; p≤ 0.001) and CLA (C18:2-n6) (-20.09% and – 27.82%; p≤ 0.001) were determined in fallow deer meat rather than in red deer and roe deer meat. Moreover, n-6 PUFA (+10.74% and +51.14%; p≤ 0.001), n-3 PUFA (+5.99% and +6.79%; p≤ 0.001), the total PUFA (+10.29% and +29.37%; p≤ 0.001), the total UFA (+8.21% and +5.56%; p≤ 0.001), and the UFA/SFA ratio (+20.93% and +14.71%; p≤ 0.001) were highest in red deer compared with fallow deer and roe deer meat. Furthermore, amongst the three deer species, the roe deer meat had the lowest PUFA/SFA ratio (0.55) and AI value (0.46), and the highest H/H ratio (1.97) and NVI (2.46) (p≤ 0.001).

Amino acid profile of deer meat

The AA profiles of the *M. longissimus lumborum* from fallow deer, red deer, and roe deer are presented in Table 4. Species significantly affected the AA profile of deer meat. The lowest proportions of isoleucine (-12.20% and – 10.00%; p=0.0080), valine (-6.61% and – 6.61%; p=0.0079), alanine (-9.52% and – 8.28%; p≤ 0.001), proline (-12.63% and – 8.79%; p=0.0012), and serine (-13.21% and – 12.38%; p≤ 0.001) were determined in fallow deer compared with the proportions in red deer and roe deer meat. The content of methionine was lower in red deer than in fallow deer and roe deer (p≤ 0.001). The content of arginine and cysteine was lower in roe deer than in fallow deer and roe deer (p≤ 0.001). The ratio of essential AAs to total AAs did not differ among deer species, while a higher content of non-essential AAs was found in red deer than in fallow deer meat (+7.96%; p=0.0045). The ratio of essential to non-essential AAs was the highest in fallow deer (1.04) and lowest in red deer meat (0.94) (p≤ 0.001).

Table 4. The effect of game species (fallow deer, red deer, and roe deer) on content of amino acids (AAs) of deer meat (*M. longissimus lumborum*) (n=6)

Parameters (g/100 g muscle)	Fallow deer	Red deer	Roe deer	SEM	p value
Essential AAs					
Arginine	1.25^{A}	1.17^{A}	0.81^{B}	0.072	≤ 0.001
Histidine	0.86	0.85	0.82	0.042	0.497
Isoleucine	1.08^{A}	1.23^{B}	1.20^{B}	0.051	0.008
Leucine	1.80^{AB}	1.67^{A}	1.86^{B}	0.063	0.005
Lysine	1.98^{A}	2.08^{A}	2.27^{B}	0.075	0.001
Methionine	0.66^{A}	0.42^{B}	0.65^{A}	0.028	≤ 0.001
Phenylalanine	1.10	1.01	1.03	0.047	0.061
Threonine	0.99^{A}	0.93^{AB}	0.91^{B}	0.034	0.021
Valine	1.13^{A}	1.21^{B}	1.21^{B}	0.032	0.008
Non-essential AAs					
Alanine	1.33^{A}	1.47^{B}	1.45^{B}	0.028	≤ 0.001
Aspartic acid	2.12	2.23	2.20	0.064	0.122
Cysteine	0.17^{A}	0.17^{A}	0.11^{B}	0.011	≤ 0.001
Glutamic acid	3.20^{A}	3.66^{B}	3.41^{AB}	0.118	0.001
Glycine	0.88^{A}	0.83^{AB}	0.81^{B}	0.029	0.016
Proline	0.83^{A}	0.95^{B}	0.91^{B}	0.033	0.001
Serine	0.92^{A}	1.06^{B}	1.05^{B}	0.028	≤ 0.001
Tyrosine	0.98	0.91	0.93	0.034	0.063
Essential AAs	10.84	10.55	10.76	0.327	0.541
Non-essential AAs	10.43^{A}	11.26^{B}	10.86^{AB}	0.256	0.005
Total AAs	21.27	21.81	21.62	0.566	0.512
Essential/non-essential AAs	1.04^{A}	0.94^{B}	0.99^{C}	0.015	≤ 0.001

Data are presented as means and standard error of means (SEM); **A, B, C** – Means within the same row with different superscripts differ significantly (p≤ 0.05).

DISCUSSION

Proximate composition of deer meat

In the present study, the proximate composition of deer meat was similar to that reported by other authors for fallow deer, red deer, and roe deer meat [2,7,10]. Opposite to that, other authors have determined more favourable proximate composition of deer meat than in the present study, in terms of higher protein content and lower fat content [8,16]. Although the nutritional value of deer meat in this study was lower than that reported in the literature, it was still high since the protein content of deer meat was higher than 22% and fat content was lower than 2%. Moreover, the proximate composition of deer meat did not differ among the three examined species, although Milczarek et al. [8] found higher protein content and lower fat content in roe deer than in red deer. In the current study, deer were exposed to the same region, rearing condition, feeding regime, and hunting type, and animals were of the same sex and age. It seems that those factors have a stronger influence on the proximate composition of the meat than deer species, since other authors have found their significant effects on the proximate composition of deer meat [2,5,9,10,14,16].

Mineral content of deer meat

The most abundant macrominerals in deer meat were K, P, and Na. Similar results for the levels of K, P, and Na in red deer meat were reported by Lorenzo et al. [11], Soriano et al. [5], and Serrano et al. [16], although content of macrominerals differed among compared studies. In the present study, deer species affected the content of Ca, P, Na, and Mg. The content of P, Na, and Mg was higher, while the content of Ca was lower in roe deer meat than in fallow deer and red deer meat. Moreover, in deer meat, Fe and then Zn predominated among the microminerals. Higher Fe than Zn levels were found in red deer and roe deer meat [11], although the contents of these microminerals were higher than those determined herein. Opposite to that, higher contents of Zn than Fe were found in red deer meat [5,16]. Similarly, as for macrominerals, in the present study, species affected the content of Fe, Mn, and Zn. Lower contents of Fe and Mn, but higher content of Zn were found in our roe deer than in fallow deer meat.

Mineral content in deer meat depends on animal diet, since deer graze and browse plants from the environment, and thus the mineral composition of deer meat reflects the mineral composition of plants ingested from the local habitat [11]. Aside from age, sex, hunting region, and season that were shown not to differ between deer meat in the present study, other factors such as different physical activities, muscle fibre type can also affect the mineral content of meat [11]. In addition, the mineral content in meat varies depending on the stage of growth of antlers that grow in red deer and fallow deer from spring to summer months, and in roe deer later, from December

to February. Rapid growth of antlers can cause a depletion of mineral stores in the body in order to transfer the minerals to the antlers [16]. There is also evidence that, in addition to Ca and P, other mineral elements also affect growth, composition, and mechanical properties of antlers [33]. This could explain the differences in the mineral content of deer meat from the present study and higher levels of P, Mg, and Zn in roe deer than in fallow deer and red deer, since the studied animals were hunted in October when antlers of red deer and fallow deer had recently finished their growth, while roe deer antlers had still not been cast. Thus, Zn, which forms part of alkaline phosphatase, the enzyme needed to deposit Ca in bone tissue, is involved in antler growth, as is Mg, which can substitute Ca in the hydroxyapatite forming the antlers and bones [16]. Despite Ca levels being relatively stable in deer blood [16], it seems that the lower content of Ca in roe deer meat than in red deer and fallow deer meat from the present study, could be ascribed to factors other than growth of antlers.

Fatty acid composition of deer meat

In the present study, among the FA classes, SFA were predominant, followed by MUFA and then PUFA in deer meat. These results are consistent with those obtained in other studies on deer meat [6,8,9,12]. Opposite to our results, Nagy et al. [13] found a higher proportion of total PUFA than total SFA and total MUFA in roe deer and red deer. However, other authors found higher levels of total SFA in fallow deer, red deer, and roe deer than the levels we detected in our deer meat [6,10,34]. In the present study, the highest level of total SFA was found in fallow deer and the lowest level was detected in red deer. Moreover, the total SFA level in deer meat was mainly a consequence of high contents of C16:0 and C18:0, aligning previous studies [2,7-12,16,17,34]. The highest proportions of C12:0, C14:0, and C16:0 fatty acids, compounds that are linked with increased levels of all cholesterol fractions and adverse cardiovascular events [35], were found in fallow deer from the present study. The FA composition of food is critical as it can affect human health and the development of vascular and coronary diseases. In general, long chain SFAs (C12-18) have been identified as a risk factor for human health and may increase the incidence of cardiovascular diseases [38,39]. In the present study the high SFA content in deer meat could be ascribed to bacterial lipolysis and subsequent biohydrogenation of ingested PUFA to SFA in the rumen, with the consequently high tissue deposition of SFA in ruminants [40].

In the present study the percentages of total MUFA in deer meat were similar to those reported by Daszkiewicz and Kondratowicz [34], Kilar and Kasprzyk [12], and Milczarek et al. [8]. Opposite to the present results, lower proportions of total MUFA were found in fallow deer, roe deer and red deer by other authors [10,13,17]. In this study, the highest level of total MUFA was determined in roe deer meat, the lowest level was found in fallow deer meat, and the most abundant MUFA was oleic acid. Similarly, in other studies, oleic acid was also the predominant MUFA [16,17,34]. In general, the major MUFA in ruminants, oleic acid, has been found to lower LDL-

cholesterol and may increase the beneficial HDL-cholesterol. Thus, meat rich in oleic acid may reduce risk factors for cardiovascular diseases [41].

Further, the PUFA contents of red deer, roe deer, and fallow deer meat ranged from 23.12 to 29.91% and were similar to those reported by Razmaite et al. [2], Švrčula et al. [10], and Milczarek et al. [8]. On the contrary, other authors found that total PUFA accounts for more than 45% of total fatty acids in red deer and roe deer [13], while total PUFA levels of less than 20% were determined in fallow deer, roe deer, and red deer [6,34]. Such discrepancies of results in previous studies indicate that the FA profile of deer meat depends on many factors, perhaps especially on diet and deer species [8,13]. In the present study the highest total PUFA, total n-6 PUFA, and total n-3 PUFA were found in red deer meat, while the lowest proportions of these listed FAs were detected in roe deer meat mainly due to differences in levels of linoleic, gamma-linolenic, arachidonic, docosadienoic, eicosatrienoic, and docosapentaenoicacids. Opposite to our results, higher total PUFA was found in roe deer than in red deer [6,8]. Although deer from the present study were all exposed to the same location and natural feed, it seems the red deer preferred plants with higher n-6 PUFA and n-3 PUFA content and/or that the rate of biohydrogenation of ingested PUFA to SFA in red deer rumen was lower compared to other deer species.

In terms of human requirements, alpha-linolenic (ALA) and linoleic acid (LA), as precursors of long-chain PUFA, are the most important PUFAs [12]. Although, dietary ALA can be converted to eicosapentaenoic (EPA) and docosahexaenoic fatty acids (DHA), the rate of conversion is very slow in humans, thereby making EPA and DHA to be regarded as very essential [42]. In the current study, the highest level of ALA (C18:3-n3) was found in roe deer meat, while the highest level of the sum of EPA and DHA was detected in fallow deer. Generally, an abundance of n-3 PUFA in the human diet is good for the treatment of neurological problems, symptomatic relief of inflammatory disorders, improvement of whole-body metabolism, and for reducing the risk of cardiovascular diseases, although the beneficial effects are related to the dietary amounts of FAs consumed. The suppressive effect of ALA on blood levels of total cholesterol, LDL-cholesterol and triacylglycerol concentrations has been demonstrated, as has the fact that ALA slightly reduces risk of cardiovascular diseases [35]. Moreover, EPA and DHA reduce the concentration of triglycerides and activate anti-inflammatory, anticoagulant, antioxidant, and antiatherogenic mechanisms [12]. Moreover, concentrations of circulating DHA and EPA are inversely proportional to the prevalence of cardiovascular diseases [35]. From the level of individual n-3 PUFAs, it is hard to conclude which deer meat from the present study has the more desirable FA profile.

Nowadays, considerable attention has been given to CLA, a fatty acid naturally found in ruminant animal products, due to its proven anti-obesogenic, ant-carcinogenic, and anti-atherosclerotic properties [36,37]. CLA is derived from the biohydrogenation of linoleic acid by bacteria in the rumen [36]. In the present study, the percentage of CLA ranged from 1.79 to 2.48% and was lower in fallow deer than in the other two deer

species. Similar levels of CLA in deer meat have been previously reported [12]. The CLA content of ruminant food products is highly dependent on various factors, such as the type of feed, age and breed of the animal, environmental season, and the rumen pH [36]. Compared with grains, grasses and fodders contain relatively high levels of PUFA, and so yield a higher CLA contents in the animals. On the other hand, grain consumption decreases the rumen pH, thus reducing the activity of rumen bacteria that produce CLA [12, 36]. Although the level of linoleic acid, the precursor of CLA, was intermediate in fallow deer meat from the present study, the amount of CLA in this meat could be ascribed to intrinsic factors, likely to lower activity of rumen bacteria.

When assessing the nutritional value of meat, it is important to calculate the ratios of PUFA to SFA and of n-6 to n-3 PUFA, as well as to determine AI, TI, H/H, and NVI.

In the present study the PUFA/SFA ratio for all three species of deer meat was above the minimum recommended value of 0.4 that reduces a risk of atherosclerotic cardiovascular diseases by lowering levels of LDL-cholesterol and total cholesterol in serum [43]. Higher PUFA/SFA ratios for red deer and roe deer were obtained by other authors [17]. In the current study a more favourable PUFA/SFA ratio was detected in red deer meat than in fallow and roe deer meat; this was due to the higher level of total PUFA in red deer meat than in other two deer species. As was previously mentioned, the higher PUFA level detected in our red deer could be ascribed to greater intake of plants with abundant n-6 PUFA and n-3 PUFA and/or to the rate of biohydrogenation of PUFA to SFA in red deer rumen being lower compared to that in other deer species.

In the present study, the n-6/n-3 PUFA ratio in deer meat ranged from 1.60 to 2.26, well below the recommended maximum of 4 [44]. This not only meets dietary guidelines but also has the potential to enhance the overall human health by preventing cardiovascular diseases, cancer, inflammatory and autoimmune diseases [45].

In other studies, similar ratios of n-6/n-3 PUFA have been determined [2,13,17]. In previously mentioned studies, the free-living deer used were exposed to natural feed without supplementation of grains in diet. Opposite to these results, Švrčula et al. [10] found a higher n-6/n-3 PUFA ratio in fallow deer that were provided with grains. Grazing ruminant meat has a high content of alpha-linolenic acid and a low n-6 to n-3 PUFA ratio, since alpha-linolenic acid is found in grass [46]. Although red deer from the present study had the highest content of n-3 PUFA, roe deer had the lowest n-6 to n-3 PUFA ratio, indicating the preferable FA profile of this meat compared to red deer and fallow deer meat.

AI, TI, H/H, and NVI indicate the impact of FA profile on human health and particularly on the prevalence of atherosclerotic diseases [8]. It is assumed that low AI is beneficial for human health since this marker is related to the reduction of total cholesterol level and level of LDL-cholesterol in humans [37]. Moreover, TI presents the thrombogenic potential of FAs, and low TI is beneficial for human health [12,37]. In the present study, AI and TI ranged from 0.46 to 0.63 and from 0.71 to 0.84,

respectively. Similar results were obtained by other authors for fallow deer, red deer, and roe deer [2,8,12,17]. Regarding the atherogenic and thrombogenic potentials of deer meat, in the present study the lowest AI was determined in roe deer meat, while the lowest TI was determined in red deer meat. Other authors have found that red deer meat has higher AI and TI values than roe deer meat [8].

On the other hand, higher H/H ratio and NVI are considered more beneficial for human health and reduce the risk of coronary heart disease [37]. In the present study, the H/H ratio and NVI ranged from 1.28 to 1.97 and from 1.69 to 2.46, respectively. Regarding the H/H ratio, higher values were determined in other studies for roe deer, red deer, and fallow deer [2,12,16,17]. Moreover, we detected the highest H/H ratio and NVI in roe deer meat, but the lowest values were in fallow deer meat. Considering all four nutritional indexes, we conclude that deer meat from the present study had favourable nutritive values that could be ascribed to the animals' active lifestyles and the specific biodiversity of their natural feeding grounds [8]. Furthermore, based on nutritional indexes (n-6/n-3 PUFA ratio, AI, H/H ratio, and NVI), it is concluded that roe deer had the highest, while fallow deer had the lowest nutritive value.

Amino acid profile of deer meat

The AA profiles of fallow deer, red deer, and roe deer meat in the present study revealed similar contents of essential and non-essential AAs as other authors have found in red deer and fallow deer [11,14]. Moreover, lysine and leucine from the present study were the most abundant essential AAs, while glutamic acid, aspartic acid, and alanine were the most dominant non-essential AAs in deer meat. Similarly to the results of the present study, other authors found that lysine, leucine, glutamic, and aspartic acids were considered as major AAs in red deer, roe deer, and fallow deer meat [11,14,16]. The content of essential and non-essential AA in deer meat can be affected by hunting region, season, diet, sex, and animal age [11,14,16]. In the present study, deer species affected the content of various essential and non-essential AA, where lower levels of isoleucine, valine, alanine, proline, and serine were found in fallow deer meat than in red deer and roe deer meat. Furthermore, roe deer meat contained the lowest levels of arginine and cysteine, and the highest level of lysine, more than in fallow deer and red deer meat. In ruminants, the absorbed AAs mainly originate from microbial protein synthesis, and partly from dietary AAs that escaped ruminal degradation [4]. Moreover, during antler growth, the dietary protein and AA requirements are high for cervids, since velvet growth demands formation of collagen fibres and blood vessel dermis rich in proteins and AAs [4]. Similarly, as for minerals, rapid growth of antlers can result in reduction of protein and AA content in animal tissues in order to incorporate AAs in antlers. Therefore, lower proportions of certain AAs in fallow deer than in the two other deer species, and the higher level of lysine connected with collagen formation (hydroxylysine) in roe deer than in fallow deer and red deer could be ascribed to the recently finished growth of antlers in red deer and fallow deer. Although the content of certain essential AAs was lower in fallow deer

than in red deer and roe deer meat, the ratio of essential to non-essential AAs was the highest in fallow deer compared to the two other deer species.

CONCLUSION

In this study, the protein content of deer meat (*M. longissimus lumborum*) exceeded 22%, while the fat content remained below 2%, highlighting its high nutritional value regardless of species the proximate composition of deer meat did not differ among deer species. Despite the relatively small sample size, that is considered to be the main limitation of the study, we successfully identified significant differences in mineral, fatty acid and amino acid composition across the three deer species. Regarding the mineral content, roe deer meat exhibited higher levels of P, Na, and Mg, but lower levels of Ca compared to fallow deer and red deer. Fallow deer meat had a higher Fe content than both red deer and roe deer. Additionally, fallow deer showed a higher Mn content and lower Zn content than roe deer. Analysis of the FA profile of deer meat showed that SFA were the most common of the FA groups (from 39.09% to 43.68%), followed by MUFA (from 29.20% to 34.59%) and PUFA (from 23.12% to 29.91%). Species significantly affected the content of FA in deer meat. The total SFA was the highest in fallow deer and the lowest in red deer meat. The highest level of total MUFA was determined in roe deer meat and the lowest level was found in fallow deer meat. Moreover, n-6 PUFA, n-3 PUFA, the total PUFA, the total UFA, and the UFA/SFA ratio were highest in red deer meat. The PUFA/SFA ratio and n-6/n-3 PUFA ratio were, for all three deer species, within recommended values. Furthermore, based on nutritional indexes (n-6/n-3 PUFA ratio, AI, H/H ratio, and NVI), it is concluded that roe deer had the highest, while fallow deer had the lowest nutritive value.

As for amino acid composition, lysine and leucine were the most abundant essential AAs, while glutamic acid, aspartic acid, and alanine were the most dominant non-essential AAs in deer meat. Although the content of certain essential AAs was lower in fallow deer meat than in red deer and roe deer meat, the ratio of essential to non-essential AA was higher in fallow deer than in the two other deer species.

A larger-scale study should be conducted to confirm and further validate these findings.

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Authors' contributions

MS and MBC participated in conceptualization, resources, project administration, and funding acquisition, MG, and MK participated in methodology, MS, NG, and ML participated in formal analysis, NG, BB, and ML participated in investigation, MG and MK participated in data curation, MS and BB participated in software, MG, MS, and MBC participated in validation, MS participated in writing – original draft preparation

and visualization, MS, MG, and MBC participated in writing – review and editing, MBC participated in supervision. All authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy of the integrity of any part of the work are appropriately investigated and resolved.

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ORCID iDs

Marija Starčević https://orcid.org/0000-0002-0857-5218
Nataša Glamočlija https://orcid.org/0000-0003-4799-9416
Branislav Baltić https://orcid.org/0000-0003-2603-2521
Milica Glišić https://orcid.org/0000-0002-6178-1758
Milica Laudanović https://orcid.org/0009-0008-6381-2803
Milena Krstić https://orcid.org/0000-0001-6915-062X
Marija Bošković Cabrol https://orcid.org/0000-0002-5827-0447

REFERENCES

1. FAOSTAT: Livestock primary, production quantity, game meat. 2019. http://www.fao.org/faostat/en/#data/QCL (accessed August 2021.).
2. Razmaite V, Siukscius A, Sveistiene R, Bliznikas S, Svirmickas GJ: Comparative evaluation of longissimus and semimembranosus muscle characteristics from free-living and farmed red deer (*Cervus elaphus*) in Lithuania. Zool Ecol 2017, 27: 176–183.
3. Costa H, Mafra I, Oliveira MBPP, Amaral JS: Game: Types and Composition. In: The Encyclopedia of Food and Health. Caballero, B., Finglas, P., Toldrá, F. Eds. Oxford, Academic Press; 2016, 177-183.
4. Ny V, Needham T, Ceacero F: Potential benefits of amino acid supplementation for cervid performance and nutritional ecology, with special focus on lysine and methionine: A review. Anim Nutr 2022, 11: 391-401.
5. Soriano A, Murillo P, Perales M, Sánchez-García C, Murillo JA, García Ruiz A: Nutritional quality of wild Iberian red deer (*Cervus elaphus hispanicus*) meat: Effects of sex and hunting period. Meat Sci 2020, 168: 108189.
6. Daszkiewicz T, Mesinger D: Fatty acid profile of meat (Longissimus lumborum) from female roe deer (*Capreolus capreolus* L.) and red deer (*Cervus elaphus* L.). Int J Food Prop 2018, 21: 2276-2282.
7. Vigano R, Demartini E, Riccardi F, Corradini A, Besozzi M, Lanfranchi P, Chiappini PL, Cottini A, Gaviglio A: Quality parameters of hunted game meat: Sensory analysis and pH monitoring. Ital J Food Saf 2019, 8: 7724.
8. Milczarek A, Janocha A, Niedziałek G, Zowczak-Romanowicz M, Horoszewicz E, Piotrowski S: Health-Promoting Properties of the Wild-Harvested Meat of Roe Deer (*Capreolus capreolus* L.) and Red Deer (*Cervus elaphus* L.). Animals 2021, 11: 2108.

9. Lukasiewicz M, Puppel K, Slosarz J, Golebiewski M, Kuczynska B, Batorska M, Wiecek J, Kunowska-Slosarz M, Popczyk B, Balcerak M: Influence of age and sex on the content of bioactive peptides and the fatty acid profile of venison (*Cervus elaphus*). Anim Sci Pap Rep 2018, 36: 371-381.
10. Švrčula V, Košinová K, Okrouhlá M, Chodová D, Hart V: The effect of sex on meat quality of fallow deer (*Dama dama*) from the farm located in the Middle Bohemia. Ital J Anim Sci 2019, 18: 498-504.
11. Lorenzo JM, Maggiolino A, Gallego L, Pateiro M, Pérez Serrano M, Domínguez R, García A, Landete-Castillejos T, De Palo P: Effect of age on nutritional properties of Iberian wild red deer meat. J Sci Food Agric 2019, 99: 1561–1567.
12. Kilar J, Kasprzyk A: Fatty Acids and Nutraceutical Properties of Lipids in Fallow Deer (*Dama dama*) Meat Produced in Organic and Conventional Farming Systems. Foods 2021, 10: 2290.
13. Nagy J, Szabó A, Donkó T, Bokor J, Romvári R, Repa I, Fébel H: Body composition and venison quality of farmed red deer (*Cervus elaphus*) hinds reared on grass, papilionaceous or mixed pasture paddocks. Arch Anim Breed 2019, 62: 227–239.
14. Bureš D, Barton L, Kudrnácová E, Kotrba R, Hoffman LC: The Effect of Barley and Lysine Supplementation on the longissimus lumborum Meat Quality of Pasture-Raised Fallow Deer (*Dama dama*). Foods 2020, 9: 1255.
15. Stanisz M, Skorupski M, Ślósarz P, Bykowska-Maciejewska M, Składanowska-Baryza J, Stańczak L, Krokowska-Paluszak M, Ludwicz A: The seasonal variation in the quality of venison from wild fallow deer (*Dama dama*) – A pilot study. Meat Sci 2019, 150: 56-64.
16. Serrano MP, Maggiolino A, Landete-Castillejos T, Pateiro M, Barbería JP, Fierro Y, Domínguez R, Gallego L, Garcia A, De Palo P, Lorenzo JM: Quality of main types of hunted red deer meat obtained in Spain compared to farmed venison from New Zealand. Sci Rep 2020, 10: 12157.
17. Razmaite V, Pileckas V, Šiukščius A, Juškiene V: Fatty Acid Composition of Meat and Edible Offal from Free-Living Red Deer (*Cervus elaphus*). Foods 2020, 9: 923.
18. Schwegmann S, Hendel AL, Frey J, Bhardwaj M, Storch I: Forage, forest structure or landscape: What drives roe deer habitat use in a fragmented multiple-use forest ecosystem? For Ecol Manag 2023, 532: 120830.
19. Official Gazette of the Republic of Serbia (No. 41/2009). Zakon o dobrobiti životinja [The Law on Animal Welfare] [In Serbian]. 2009. https://pravno-informacioni-sistem.rs/eli/rep/sgrs/skupstina/zakon/2009/41/16/reg.
20. Official Gazette of the Republic of Serbia (No. br. 18/2010, 95/2018, 92/2023). Zakon o divljači i lovstvu [The law about game and hunting] [In Serbian]. 2010. https://pravno-informacioni-sistem.rs/eli/rep/sgrs/skupstina/zakon/2010/18/8/reg.
21. England and Wales Best Practise Guide. Records & Surveys: Aging by teeth. 2008. https://www.thedeerinitiative.co.uk/uploads/guides/110.pdf (accessed May 2019).
22. International Organization for Standardization. ISO 1442. Meat and meat products. Determination of moisture content (Reference method). 1997.
23. International Organization for Standardization. ISO 1443. Meat and meat products. Determination of total fat content. 1973.
24. International Organization for Standardization. ISO 937. Meat and meat products. Determination of nitrogen content. 1978.

25. International Organization for Standardization. ISO 936. Meat and meat products. Determination of total ash. 1998.
26. International Organization for Standardization. ISO 13730. Meat and meat products. Determination of total phosphorus content – Spectrometric method. 1996.
27. Bošković Cabrol M, Glišić M, Baltić MŽ, Jovanović D, Silađi Č, Simunović S, Tomašević I, Raymundo A: White and honey Chlorella vulgaris: Sustainable ingredients with the potential to improve nutritional value of pork frankfurters without compromising quality. Meat Sci 2023, 198: 109123.
28. Spirić A, Trbović D, Vranić D, Djinović J, Petronijević R, Matekalo-Sverak V: Statistical evaluation of fatty acid profile and cholesterol content in fish (common carp) lipids obtained by different sample preparation procedures. Anal Chim Acta 2010, 672: 66–71.
29. Glišić M, Baltić M, Glišić M, Trbović D, Jokanović M, Parunović N, Suvajdzić B, Bošković M, Vasilev D: Inulin-based emulsion-filled gel as a fat replacer in prebiotic-and PUFA-enriched dry fermented sausages. Int J Food Sci 2019, 54: 787–797.
30. Ulbricht TLV, Southgate DAT: Coronary heart disease: Seven dietary factors. Lancet 1991, 338: 985–992.
31. Paszczyk B, Polak-Sliwinska M, Luczynska J: Fatty Acids Profile, Trans Isomers, and Lipid Quality Indices in Smoked and Unsmoked Cheeses and Cheese-Like Products. Int J Environ Res Public Health 2020, 17: 71.
32. Chen Y, Qiao Y, Xiao Y, Chen H, Zhao L, Huang M, Zhou G: Differences in physicochemical and nutritional properties of breast and thigh meat from crossbred chickens, commercial broilers, and spent hens. Asian-Australas J Anim Sci 2016, 29: 855–864.
33. Landete-Castillejos T, Kierdorf H, Gomez S, Luna S, García AJ, Cappelli J, Pérez-Serrano M, Pérez-Barbería J, Gallego L, Kierdorf U: Antlers – Evolution, development, structure, composition, and biomechanics of an outstanding type of bone. Bone 2019, 128: 115046.
34. Daszkiewicz T, Kondratowicz J: Fatty acid profile and sensory properties of roe deer meat after modified atmosphere storage. Ital J Food Sci 2020, 32: 645.
35. Shramko VS, Polonskaya YV, Kashtanova EV, Stakhneva EM, Ragino YI: The Short Overview on the Relevance of Fatty Acids for Human Cardiovascular Disorders. Biomolecules 2020, 30: 1127.
36. den Hartigh LJ: Conjugated Linoleic Acid Effects on Cancer, Obesity, and Atherosclerosis: A Review of Pre-Clinical and Human Trials with Current Perspectives. Nutrients 2019, 11: 370.
37. Chen J, Liu H: Nutritional indices for assessing fatty acids: A mini-review. Int J Mol Sci 2020, 21: 5695.
38. Simopoulos A: An increase in the omega-6/omega-3 fatty acid ratio increases the risk for obesity. Nutrients 2016, 8: 128.
39. Perna M, Hewlings S: Saturated fatty acid chain length and risk of cardiovascular disease: A systematic review. Nutrients 2022, 21:30.
40. Scollan ND, Dannenberger D, Nuernberg K, Richardson I, MacKintosh S, Hocquette JF, Moloney AP: Enhancing the Nutritional and Health Value of Beef Lipids and Their Relationship with Meat Quality. Meat Sci 2014, 97: 384–394.
41. Smith S: Marbling and its nutritional impact on risk factors for cardiovascular disease. Korean J Food Sci Anim Resour 2016, 36: 435-444.

42. Hathwar, S.C.; Rai, A.K.; Modi, V.K.; Narayan, B. Characteristics and consumer acceptance of healthier meat and meat product formulations – a review. J. Food Sci. Technol 2012, 49, 653–664.
43. Wood, J.D.; Enser, M.; Fisher, A.V.; Nute, G.R.; Sheard, P.R.; Richardson, R.I.; Hughes, S.I.; Whittington, F.M. Fat deposition, fatty acid composition and meat quality: A review. Meat Sci 2008, 78, 343-358.
44. Alagawany, M.; Elnesr, S.S.; Farag, M.R.; Abd El-Hack, M.E.; Khafaga, A.F.; Taha, A.E.; Dhama, K. Omega-3 and Omega-6 Fatty Acids in Poultry Nutrition: Effect on Production Performance and Health. Animals 2019, 18, 573.
45. Simopoulos, A.P. The omega-6/omega-3 fatty acid ratio: health implications. OCL Oils. Fat. Crop. Li 2010, 17, 267-275.
46. 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 Sci 2004, 66, 21–32.

NUTRITIVNA VREDNOST MESA JELENSKE DIVLJAČI: JELENA LOPATARA (*DAMA DAMA*), EVROPSKOG JELENA (*CERVUS ELAPHUS*) I SRNE (*CAPREOLUS CAPREOLUS*)

Marija STARČEVIĆ, Nataša GLAMOČLIJA, Branislav BALTIĆ, Milica GLIŠIĆ, Milica LAUDANOVIĆ, Milena KRSTIĆ, Marija BOŠKOVIĆ CABROL

Cilj ovog rada je bio upoređivanje osnovnog hemijskog, mineralnog, masnokiselinskog i aminokiselinskog sastava i nutritivne vrednosti mesa tri vrste jelenske divljači (jelen lopatar, evropski jelen i srna). Ukupno je prikupljeno osamnaest trupova od jedinki muškog pola tri vrste jelenske divljači. Osnovni hemijski sastav mesa jelenske divljači nije se razlikovao između tri poređene vrste jelena, dok je vrsta jelenske divljači uticala na sadržaj većine minerala u mesu (Ca, P, Na, Mg, Fe, Mn i Zn). Analizom masno-kiselinskog sastava mesa jelenske divljači utvrđeno je da je odnos polinezasićenih masnih kiselina (PUFA) prema zasićenim masnim kiselinama i odnos n-6/n-3 PUFA za sve tri vrste jelenske divljači bio u granicama preporučenih vrednosti. Pored toga, na osnovu nutritivnih indeksa (odnos n-6/n-3 PUFA, indeks aterogenosti, odnos hipoholesterolemičnih i hiperholesterolemičnih masnih kiselina i indeks nutritivne vrednosti), utvrđeno je da meso srne ima najvišu, a meso jelena lopatara najnižu nutritivnu vrednost. Iako je sadržaj pojedinih esencijalnih aminokiselina (izoleucin i valin) bio manji u mesu jelena lopatara nego u mesu evropskog jelena i srne ($p \leq 0,05$), odnos esencijalnih i neesencijalnih aminokiselina bio je veći kod jelena lopatara nego kod dve druge vrste jelena ($p \leq 0,05$).