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Fatty Acids Composition of Elk, Deer, Roe Deer and Wild Boar Meat Hunted in Latvia

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Abstract**—**A game animals – elk (*Alces alces*), deer *(Cervus elaphus*), roe deer (*Capreolus capreolus)* or wild boar *(Sus scrofa scrofa)* - every autumn and winter period provide an excellent investment, diversification of many consumer meals. In last years consumption and assortiment of game meat products significantly increase. Investigations about biochemical composition of game meat are not very much. The meat of wild animals is more favourable for human health because it has lower saturated fatty acids content, but higher content of protein. Therefore the aim of investigations was to compare biochemical composition of ungulates obtained in Latvia.Investigations were carried out in wild animals different regions of Latvia. In the studied samples protein, intramuscular fat, fatty acids and cholesterol were determined. The biochemical analysis of 54 samples were done. Results of analysis showed that protein content 22.36 – 22.92% of all types of meat samples is not different statistically, significantly lower fat content 1.33 ± 0.88% had elk meat samples and 1.59 ± 0.59% roe deer samples. Content of cholesterol was various 64.41 – 95.07% in the ruminant meat samples of different species. From the dietetic point of view the best composition of fatty acids has meat samples of roe deer.

Keywords**—**dietic product, game meat, intramuscular fat

I. Introduction

THE statistics show that the Latvian registered around 33.000 hunters, out of which 17.000th are actively huntsmens. During the hunting produced an average of around 2624 tons (2548 – auhiliaries service) of game meat in Latvia. Wild game meat is considered significant, and its share in consumption in recent years, increasing in size. Currently among consumers there is increased interest in meat from animals kept in conditions as close as possible to the natural ones. Such a requirement is undoubtedly fulfilled by game characterized by high nutritional value and special sensory properties, desired by consumers [1], [2].

Meat quality is a wide-ranging term, encompassing such diverse issues as technological, nutritional, hygienic and sensoric. Many factors have an impact on ruminant and wild boar meat quality; they can generally be divided into two categories: somatic factors (e.g. breed, age, sex) and environmental factors (e.g. diet, climate, hunting procedures) [3]. Meat characteristics may be changed due to the dietary components particularly fat content and composition [4], [5].

Any improvement of meat production by nutritional means should take into consideration the composition and palatability of the meat and human health. Polyunsaturated fatty acids are not produced in human organism therefor these must be commited with products of animal origin mostly fish, but wild animals meat also is one of good source.

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Composition of fatty acids, especially ratio of polyunsaturated fatty acids (PUFA) to saturated fatty acids (SFA) (PUFA/SFA), is more significant for human health than total fat content. MacRae et al. noted that lowering content of saturated faty acids, especially myristic acid (C14:0) and lauric acid (C12:0) improve level of cholesterol in blood and lowered risk of heart diseases [6]. Wood reported that recommended ratio PUFA/SFA must be higher than 0.4 and that domestic animals it has too low 0.1 [7]. On other hand too much polyunsaturated ω-6 fatty acids level give undiserable impact to human health because produced eicoasanoids (C20:3) of inflammation, but inflammation are involved in the development of heart diseases and cancer. Enriching diet with polyunsaturated ω-3 fatty acids lowered risk of atherosclerosis, hipertension and artrite in human organism. Both ω-6 and ω-3 fatty acids are essential for humans, and our diet must contain balanced amounts [8], [9]. Therefore ratio ω-6/ω-3 is such significant. WHO [10] suggest mentioned ratio lower than 4 . This ratio is lower if animals are grazed because green forage has higher content of linoleic acid [7].

Typical for meat are saturated fatty acids (SFA). Such ruminants as cattle and sheep has higher content of SFA 44-46%, wild animals has lower content of SFA 41% [11]. Strategies that lead to an increase in the PUFA/SFA ratio in intramuscular fat would improve the healthiness of meat from a consumer perspective [12].

The aim of our investigation was to analyse the composition of elk, deer, roe deer and wild boar meat and to compare the composition of fatty acids.

II. Materials and Methods

Meat samples (*m. logissimus lumborum*) were collected in the autumn-winter season. The research was conducted at the laboratory of Biochemistry and Microbiology of the Research institute of Biotechnology and Veterinary Medicine „Sigra". The chemical analyses of 54 samples were done, i.e. elk (8), deer (18), roe deer (16), wild boar (12) meat samples after hunting in whole regions in Latvia were collected. In the studied samples protein, fat, cholesterol content and fatty acids composition were determined. Sample preparation was made in 48 hours after slaughtering or hunting. Meat samples of abaut 300 g were homogenized with BŰCHI B-400 (ISO 3100-1).

Protein content was determined as total nitrogen content by Kieldahl method and using coefficient 6.25 for calculation (ISO 937:1974).

Intramuscular fat content was made by Sochlet method with hidrolysis procedure (boiling in the hydrochloric acid) using SoxCap 2047 and SOX TEH 2055 equipment (FOSS) (LVS ISO 1443:1973). Cholesterol content was detected by Blur colorimetric method using spectrometer [13].

Fatty acids analysis of meat. Homogenized meat samples were prepared for GLC (gas-liquid chromatography) analysis using direct saponification with KOH/methanol followed by a derivatization with (trimethylsilyl) diazomethane by the method of Aldai et al [14] An ACME , model 6100, GLC (Young Lin Instrument Co.) equipped with a flame ionisation detector, an automatic sample injector, and an Alltech AT-FAME analytical column (fused silica 30m×0.25mm i.d.) was used. As the carrier gas He was used with a flow rate approximately 2 mL/min. Temperature conditions of the oven, injector and detector was the same as in the method of Aldai et al. [14]. Results were evaluated with an conventional integrator program (Autochro-2000, Young Lin Instrument Co.) The individual FAMEs (fatty acid methyl esters) were identified according to similar peak retention times using standard mixture Supelco 37 Component FAME Mix.

The statistical analysis was performed using SPSS 17. One-way ANOVA was used for comparison mean values. Statistical significance was declared at $p < 0.05$.

III. Results and Discussion

Biochemical composition of meat samples were evaluated and results are assumed in the Table I. From results of investigation we can conclude that calculated content of protein in samples of game meet was 22.36–22.92%, richest were samples of wild boar meet. Results of statistical analysis showed that protein content of game meat samples did not differ significantly ($p = 0.297 > 0.05$).

TABLE I
Biochemical Composition of Game Meat

Group	n	Proutein, %	Fat, %	Cholesterol, mg $100g^{-1}$
Elk	8	22.72 ± 0.60	1.33 ± 0.88	64.41 ± 4.99
Deer	18	22.36 ± 1.37	1.90 ± 1.29	70.57 ± 2.49
Reo deer	16	22.82 ± 1.76	1.59 ± 0.59	67.92 ± 4.46
Boar	12	22.92 ± 2.88	2.82 ± 1.26	95.07 ± 7.88

Results of the investigation showed that fat content of meat samples varied from 1.33 ± 0.88% till 2.82 ± 1.26%. Intramuscular fat content determined in meat samples of elk was the lowest and the highest in meat samples of wild boar. Results of statistical analysis showed that content of intramuscular fat content in game meat samples differ significantly ($p = 0.021 < 0.05$). Content of cholesterol in game meat samples varied from 64.41 ± 4.99 mg $100g^{-1}$ in meat samples of elk till 95.07 ± 7.88 mg $100g^{-1}$ in meat samples of wild boar ($p = 0.04 < 0.05$). Game meat possesses profitable chemical composition as a raw material of high content of protein and low content of intramuscular fat in comparison with beef. The investigation of beef samples obtained in organic production sistem in Latvia showed that average protein content was 19.61%, but content of intramuscular fat was 1.48% [15].

TABLE II
Comparison Of Fatty Acids Composition of Meat

Fatty acids, % of total	Elk	Deer	Roe deer	Boar
Saturated fatty acids (SFA)				
C 12 :0	0.19 ± 0.29	0.30 ± 0.22	0.01 ± 0.03	0.11 ± 0.15
C 14 :0	2.44 ± 1.71	4.57 ± 2.33	1.32 ± 0.79	2.92 ± 1.37
C 15 :0	0.35 ± 0.23	0.67 ± 0.13	0.44 ± 0.19	0.25 ± 0.28
C 16 :0	18.08 ± 3.04	21.02 ± 6.67	18.72 ± 3.01	23.12 ± 1.19
C 17 :0	0.90 ± 0.51	0.60 ± 0.38	1.07 ± 0.40	0.40 ± 0.20
C 18 :0	13.56 ± 2.30	14.46 ± 4.76	15.63 ± 3.10	14.54 ± 2.89
C 20 :0	0.08 ± 0.15	0.06 ± 0.01	0.02 ± 0.05	0.09 ± 0.07
C 22 :0	0.00	0.04 ± 0.15	0.04 ± 0.08	0.00
C24 :0	0.15 ± 0.32	0.41 ± 0.47	0.29 ± 0.45	0.33 ± 0.66
Monosaturated fatty acids (MUFA)				
C14 :1	1.18 ±1.44	1.62 ± 1.25	0.35 ± 0.36	0.85 ± 0.92
C15 :1	0.23 ± 0.01	0.07 ± 0.03	0.02 ± 0.03	0.05 ± 0.06
C 16 :1	4.35 ± 3.42	6.66 ± 4.61	1.95 ± 1.47	4.27 ± 1.62
C 17 :1	0.27 ± 0.29	0.31 ± 0.20	0.31 ± 0.18	0.24 ± 0.21
C 18 :1	27.89 ± 9.88	17.51 ± 3.38	26.15 ± 6.99	29.88 ± 9.27
C 20 :1	0.04 ± 0.07	0.13 ± 0.12	0.04 ± 0.06	0.24 ± 0.21
C22 :1	0.00	0.03 ± 0.07	0.00	0.09 ± 0.17
C 24 :1	0.13 ± 0.20	0.23 ± 0.36	0.14 ± 0.18	0.00
Polyunsaturated fatty acids (PUFA)				
C 18 :2 ω-6	6.90 ± 1.99	12.34 ± 7.70	11.62 ± 3.34	11.70 ± 1.96
C 18 :3 ω-3	4.77 ± 1.71	3.31 ± 1.84	3.94 ± 2.51	1.46 ± 0.92
C 18 :3 ω-6	0.04 ± 0.07	0.14 ± 0.11	0.07 ± 0.08	0.03 ± 0.05
C 20 :2	0.45 ± 0.66	0.10 ± 0.13	0.07 ± 0.06	0.26 ± 0.24
C 20 :3 ω-6	0.20 ± 0.34	0.32 ± 0.33	0.35 ± 0.27	0.14 ± 0.20
C 20 :3 ω-3	0.05 ±0.07	0.04 ± 0.05	0.00	0.12 ± 0.09
C 20 :4 ω-6	4.59 ± 1.92	4.25 ± 2.70	5.00 ± 2.02	2.02 ± 1.53
C 20 :5 ω-3	0.95 ± 0.62	1.36 ± 1.10	2.03 ± 1.29	0.39 ± 0.45
C22 :2	0.00	0.13 ± 0.20	0.05 ± 0.07	0.22 ± 0.13
C 22 :5 ω-3	0.72 ± 0.24	1.29 ±0.85	1.87 ± 0.69	0.84 ± 0.64
C 22 :6 ω-3	0.32 ± 0.54	0.20 ± 0.33	0.39 ± 0.40	0.08 ± 0.11
Sum of ω-3	6.81± 2.39	6.20 ± 3.01	8.23 ± 3.51	2.89 ± 1.03
Sum of ω-6	11.73 ± 4.48	17.05 ±6.61	17.04 ± 5.70	13.89 ± 5.83
ω-6/ω-3	1.72	2.75	2.07	4.81
P/S ratio	0.53	0.68	0.68	0.50

There are four inter-related factors that have important health ramifications: (1) the total fat content; (2) distribution of specific fatty acids; (3) the ratio of PUFA/SFA; and (4) the ratio of ω-6/ω-3 fatty acids. Each of these dietary lipid elements has been shown to influence the development of CHD [16]. Composition of dietary fat is more significant for consumers than total fat content, therefore were compared composition of fatty acids, sum of saturated, monounsaturated, polyunsaturated fatty acids. Comparison is shown in Table 2.

Increases in dietary levels of saturated fat, particularly 12:0, 14:0 and 16:0 (palmitic acid) have been identified as the major dietary factor responsible for raising total and LDL serum cholesterol concentrations [17]. From the results of investigation we can establish that average content of myristic and lauric acids that more of all influence cholesterol level in human blood significantly lower determined in meat samples of roe deer.

The lowest content of palmitic acid 18.08 ± 3.04% had elk meat samples, but wild boar samples has highest content of palmitic acid - 23.12 ± 1.19% from all fatty acids. Results of statystical analysis confirmed that sum of SFA did not differ significantly ($p = 0.283 > 0.05$).

WHO suggest ratio ω-6/ω-3 lower than 4. From results of investigation we can see that in samples of game meat this ratio varied from 1.72 in elk meat till 2.75 in deer meat, with exception wild boar meat samles. Medeiros et al. [18] reported that ratio ω-6/ω-3 of deer meat is 3.45.

As mentioned above, recommended ratio of polyunsaturated fatty acids to saturated fatty acidsones must be higher than 0.4. High relative percentages of PUFA are characteristic of all wild ruminant muscle tissue, whereas the relative percentage of PUFA in the muscle tissue of wild boar lower than that found in wild ruminants. Results of investigation show that PUFA/SFA ratio higher than 0.4 has all game meat samples, it varied from 0.50 till 0.68. Medeiros et.al. reported that ratio PUFA/SFA of beef samples is 0.38 [18].

Sum of saturated fatty acids, as same as sum of monounsaturated and polyunsaturated fatty acids in meat samples of elk, deer, roe deer and wild boar were compared. This comparison is reflected in Figure 1.

Results of investigation showed that lowest content of saturated fatty acids has meat samples of wild boar and elk meat samples - 34.79% and 35.75% respectively. Highest sum of saturated fatty acids had deer meat samples – 42.13% and it is in agreement with Petkov [4].

The sum of PUFA in game meat samples variet from17.25% till 25.39%. The highest content of the sum of PUFA had meat samles of roe deer 25.39%. Although ω-6 fatty acids are essential for health, people tend to consume too much of these substances, and arachidonic acid in particular is associated with inflammation. Inflammation can contribute to accumulation of plaque in arteries, which may increase the risk of coronary artery disease, heart attack and stroke [19].

Meat of wild animals is more favorable for human health because it has lower SFA content but higher content of polyunsaturated fatty acids [20] also, wild boar meat. Meat and fat of wild animals has significantly higher content of long chain fatty acids ω-3 than meat of domestic animals [16].

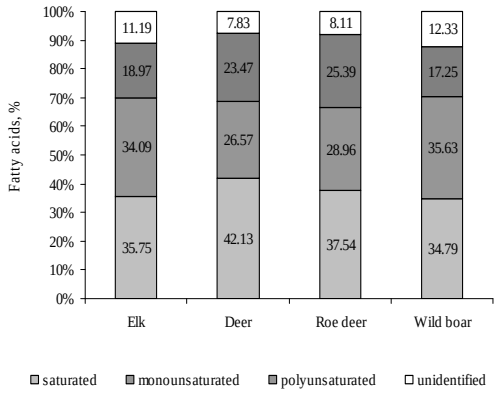

Fig. 1 Composition of groups of fatty acids in elk, deer, roe deer and boar meat samples

From the dietetic point of view the „ideal" composition of fatty acids is if amount of saturated, monounsaturated, polyunsaturated fatty acids is equal 33.3% - 33.3% - 33.3% [18]. Closest to this proportion was meat samples of roe deer, where saturated fatty acids accounted 37.54%, monounsaturated 28.96% and polyunsaturated 25.39%.

IV. Conclusions

- Protein content in samples of game meat were detected 22.36 - 22.92%, richest were samples of wild boar meat. Fat content of game meat samples varied from 1.33 - 3.23%.
- Content of cholesterol was similar in the meat samples of different ruminant species 64.41 - 70.57 mg $100g^{-1}$, but 95.07 mg $100g^{-1}$ in meat samples of wild boar
- Content of saturated fatty acids was lower in the meat samples of wild boar 34.79% and elk 35.75%.

From the dietetic point of view the best composition of fatty acids has meat samples of roe deer.

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