

Protein Quality of Game Meat Hunted in Latvia

Vita Strazdina, Aleksandrs Jemeljanovs, Vita Sterna

Abstract—Not all proteins have the same nutritional value, since protein quality strongly depends on its amino acid composition and digestibility. The meat of game animals could be a high protein source because of its well-balanced essential amino acids composition. Investigations about biochemical composition of game meat such as wild boar (*Sus scrofa scrofa*), roe deer (*Capreolus capreolus*) and beaver (*Castor fiber*) are not very much. Therefore, the aim of the investigation was evaluate protein composition of game meat hunted in Latvia. The biochemical analysis, evaluation of connective tissue and essential amino acids in meat samples were done, the amino acids score were calculate. Results of analysis showed that protein content 20.88-22.05% of all types of meat samples is not different statistically. The content of connective tissue from 1.3% in roe deer till 1.5% in beaver meat allowed classified game animal as high quality meat. The sum of essential amino acids in game meat samples were determined 7.05–8.26g100g⁻¹. Roe deer meat has highest protein content and lowest content of connective tissues among game meat hunted in Latvia. Concluded that amino acid score for limiting amino acids phenylalanine and tyrosine is high and shows high biological value of game meat.

Keywords—Dietic product, game meat, amino acids, scores.

I. INTRODUCTION

SINCE the amino acid composition of proteins from food animals is similar to human muscle and muscle makes up almost 50% of our body's weight, muscle foods are an excellent source of the amino acids needed for growth, repair, and maintenance. Average game meat protein content reported 21–25% [1]-[3]. Not all proteins have the same nutritional value, protein quality strongly depends on its amino acid composition and digestibility. Meat protein general contains 2.5-12.0% connective tissue protein [4].

There are two important aspects of protein quality: 1) the characteristics of the protein and the food matrix in which it is consumed, and 2) the demands of the individual consuming the food [5]. Quality is important not only at the minimum Recommended Dietary Allowance level but also at higher intakes. The amino acid score is assumed to predict biological value or the anticipated ability of the absorbed test protein to fulfill human amino acid requirements [6]. Foodstuffs that lack essential amino acids are poor sources of protein equivalents, as the body tends to deaminate the amino acids obtained, converting proteins into fats and carbohydrates. Therefore, a balance of essential amino acids is necessary for

a high degree of net protein utilization, which is the mass ratio of amino acids converted to proteins to amino acids supplied

The net protein utilization is profoundly affected by the limiting amino acid content; in meat limiting is a sum of phenylalanine and tyrosine [7].

The aim of our investigation was to analyze the composition of roe deer, wild boar and beaver meat and evaluate protein quality.

II. MATERIALS AND METHODS

The research was conducted at the laboratory of Biochemistry and Microbiology of the Research institute of Biotechnology and Veterinary Medicine "Sigra".

A. Sampling

Meat samples of roe deer, wild boar (*m. logissimus lumborum*) and beaver (*m. biceps femoris*) in the autumn-winter season in whole regions in Latvia were collected. The sample excised from thigh muscle as biggest and most valuable sample of beaver meat [8]. Sample preparation of wild boar (12), roe deer (16) and beaver (12) meat was made in 48 hours after slaughtering or hunting. Meat samples of about 300 g were homogenized with BÜCHI B-400 [9]. In the studied samples crude protein, intramuscular fat, ash, collagen content and composition of amino acids were determined, amount of connective tissue and amino acid score were calculate.

B. Biochemical Composition

Crude protein content was determined as total nitrogen content by Kjeldahl method and using coefficient 6.25 for calculation [10].

Intramuscular fat content was made by Soxhlet method with hidrolysis procedure (boiling in the hydrochloric acid) using SoxCap 2047 and SOX TEH 2055 equipment (FOSS).

Ash was determined by incineration in a muffle furnace at 550C for 24h (method No.920.153; AOAC1990).

Connective tissue protein was calculate via determination of specific amino acid 4-hydroxyproline, which is exclusively present in collagen. Meat samples are hydrolyzed in acid 3.5M H₂SO₄ at ~ 105°C. The 4-hydroxyproline is oxidized with 4-dimethylaminobenzaldehyde a red color develops, which is measured spectrometrically at 560nm [11]. Collagen is calculated by 8x the concentration of 4-hydroxyproline and expressed as % of total protein [4]. Ratio thryptophane to hydroxyproline was calculated as measure characterized raw material for meat production.

C. Amino Acid Analyses

Dried, defatted meat samples were hydrolysed with 6N HCl in sealed glas tubes at10°C for 23 h. Amino acids were

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detected using reversed-phase HPLC/MS (Waters Alliance 2695, Waters 3100, column XTerra MS C18 5 μ m, 1x100 mm). Mobile phase (90% acetonitrile: 10% deionized water) 0.5mlmin⁻¹, column temperature. 40°C was used. The identity and quantitative analysis of the amino acids were assessed by comparison with the retention times and peak areas of the standard amino acid mixture.

The essential amino acid score was calculated with respect to the WHO/FAO amino acid pattern of adults [6]:

Amino acid score = [sample amino acid (mg g⁻¹) / References amino acid (mg g⁻¹)] x 100

D. Statistical Analysis

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

Protein composition, intramuscular fat, ash content of game meat samples are showed in Table I.

TABLE I
BIOCHEMICAL COMPOSITION OF MEAT

Parameters	Wild boar	Beaver	Roe deer
Dry matter, %	25,38 \pm 0,62	24,93 \pm 0,71	25,86 \pm 0,86
Protein, %	20.88 \pm 2.99	21.39 \pm 1,32	22.05 \pm 1.78
Collagen content, %	30.24 \pm 1.42	32.16 \pm 1,22	28.64 \pm 1.35
Connective tissue protein, %	1.45 \pm 0.08	1.50 \pm 0,06	1.30 \pm 0.09
Intramuscular fat, %	3.45 \pm 1.67	4.29 \pm 0,98	1,63 \pm 0.76
Ash, %	1.14 \pm 0.13	1.13 \pm 0,09	1.15 \pm 0.24
Average \pm standard deviation			

Content of protein in samples of game meat was 20.88–22.05%, and richest were samples of roe deer meat. Content of protein same as dry matter, ash and connective protein among species did not differ significantly ($p > 0.05$). The results of our investigation are similar with other research findings, where protein content in roe deer meat samples was reported 21.7%, in wild boar meat samples 21.9% [2], in beaver thigh muscle samples 21.6% [3]. Investigations of Dominik and others showed higher protein 23.84%, lower fat 0.48% content in roe deer meat [1].

Not all meat proteins are of high quality, since some of them, like the connective tissue proteins (collagen, elastin, etc.), are poor in essential amino acids. The content of connective tissue which in meat is also decisive for its tenderness in game meat samples were determined from 1.30% in roe deer samples till 1.50% in beaver samples. Meat protein general contains 2.5-12% connective tissue protein [5]. From this point of view game meat (specifically *m. longissimus lumborum*) could be classified as high quality meat.

Tryptophan is one of valuable amino acid. The content of tryptophan is used as full value protein measure in product.

Content of oxyproline is significant as measure of connective tissue protein. Therefore ratio Tryptophan / Oxyproline is one of significant indicators of nutrition value of product.

Calculated ratio thryptophane to oxyproline as measure characterized raw material for meat production compared in Fig. 1.

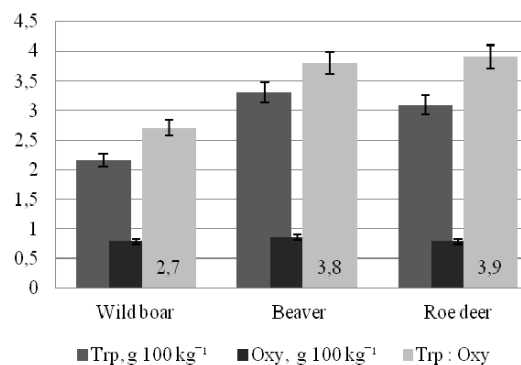


Fig. 1 Comparison of Tryptophan / Oxyproline ratio in meat samples

From nutritional point of view higher quality has roe deer meat with ratio 3.9, not so high wild boar meat ratio 2.7.

Content of extracted substances characterized wild boar, beaver and roe deer meat samples is compared in Fig. 2.

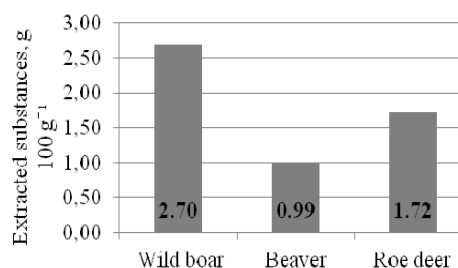


Fig. 2 Comparison of extracted substances in game meat

The highest content of extracted substances was determined in wild boar meat samples -2.7%, it is 3.5times more than determined in pig meat samples - 0.84% [12]. The lowest content of extracted substances determined in meat samples of beaver 0.99%.

Average content of amino acids, sum of indispensable amino acids in Latvia hunted roe deer, wild boar and beaver meat samples were compared in this investigation. Results are showed in Table II.

FAO/WHO recommended intake of total indispensable amino acids is 83.5 mg on kg of body weight per day [13], it is 5.8 g per human with body weight 70kg.

The sum of essential amino acids in game meat hunted in Latvia were determined from 7.05–8.26 g100g⁻¹ (Table II).

Results show that average content of amino acids significantly differed among species ($p < 0.05$). Results of investigations reported by Kataeva show that sum of essential

amino acids in roe deer meat samples determined 12.30 ± 0.47 g100g⁻¹ [14].

TABLE II
COMPOSITION OF MEAT AMINO ACIDS IN WILD ANIMAL
MUSCLE PROTEIN

Amino acids, g100g ⁻¹	Amino acid content, mg100g ⁻¹		
	Wild boar	Beaver	Roe deer
Val	0.12 ± 0.03	0.93 ± 0.15	0.88 ± 0.17
Ile	1.04 ± 0.12	1.09 ± 0.06	0.87 ± 0.21
Leu	1.61 ± 0.11	1.52 ± 0.22	1.69 ± 0.18
Lys	2.16 ± 0.58	1.71 ± 0.34	2.19 ± 0.67
Thr	0.52 ± 0.19	0.08 ± 0.02	0.93 ± 0.25
Trp	0.21 ± 0.02	0.33 ± 0.03	0.33 ± 0.61
Phe	0.91 ± 0.16	0.10 ± 0.02	0.92 ± 0.16
Met	0.56 ± 0.06	0.39 ± 0.09	0.52 ± 0.21
Tyr	0.74 ± 0.11	0.61 ± 0.09	0.76 ± 0.15
Arg	2.02 ± 0.42	1.42 ± 0.20	1.55 ± 0.27
His	1.07 ± 0.12	1.00 ± 0.05	0.87 ± 0.16
Asp	2.09 ± 0.60	1.61 ± 0.31	1.77 ± 0.32
Ser	0.79 ± 0.21	0.67 ± 0.09	0.91 ± 0.27
Glu	3.24 ± 0.61	2.95 ± 0.56	3.14 ± 0.73
Pro	0.66 ± 0.13	0.82 ± 0.19	0.81 ± 0.22
Gly	0.93 ± 0.14	0.85 ± 0.14	0.93 ± 0.28
Ala	1.22 ± 0.10	1.36 ± 0.08	1.39 ± 0.31
SCA	1.65 ± 0.14	0.71 ± 0.09	1.68 ± 0.16
IAA	7.30 ± 1.12	7.05 ± 1.23	8.26 ± 1.09
PIAA	6.00 ± 0.66	4.98 ± 0.51	5.45 ± 0.81

SCA-sulfur containing amino acids (Phe + Tyr)

IAA-the sum of indispensable amino acids (Thr + Val + Met + Ile + Leu + Trp + His + Lys)

PIAA-the sum of partly indispensable amino acids (Arg + Glu + Tyr)

The glutamic acid is the main one assigned meat taste. The content of glutamic acid determined from 2.95 g100g⁻¹ in beaver until 3.24 g100g⁻¹ in wild boar meat samples. The results of Kataeva show that content of glutamic acid determined 1.97 ± 0.05 g100g⁻¹ in male and 3.62 ± 0.18 g100g⁻¹ female roe deer samples [14].

It can be concluded from the results of the investigation, that the wild boar meat has higher dietetical value than pig samples has. The content of arginine (2.02 g100g⁻¹) and histidine (1.07 g100g⁻¹) in meat samples of wild boar are higher than pig samples has (1.02 and 0.85 g100g⁻¹ respectively) [15].

The results of essential amino acids amount in wild animal muscle protein and amino acids score are assumed in Table III.

The content of methionine, threonine and histidine and sulfur containing amino acids in roe deer meat is higher than model or ideal protein. As mentioned above content of tryptophan is used as full value protein measure in product, from this point of view wild boar and beaver meat is high value protein. The wild boar and beaver meat contain 6-9 times more tryptophan in comparison with roe deer meat samples, 2.16; 3.30 and 0.34mg per g of protein relatively.

Since net protein utilization is affected by the limiting amino acid (the sum of phenylalanine and tyrosine or SCA), all tested meat samples must be evaluated as source of protein with high biological value. Amino acid score for SCA in the model protein defined 22, calculated score for wild boar meat is 75, for beaver meat 32 and for roe deer meat 77.

TABLE III
THE SUM OF ESSENTIAL AMINO ACIDS IN WILD ANIMAL
MUSCLE PROTEIN

Essential amino acids	model, mg g ⁻¹ *	Amino acid content, mg per g of protein (score)		
		Wild boar	Beaver	Roe deer
Thr	23	5.21(23)	0.84(4)	9.4(40)
Val	39	1.23(3)	9.31(24)	8.8(23)
Met	16	5.59 (35)	3.87 (24)	5.20 (33)
Ile	30	10.43 (35)	10.85 (36)	8.8 (29)
Leu	59	16.09 (27)	15.22 (26)	16.90 (29)
Trp	6	2.16 (36)	3.30 (55)	0.34 (5)
His	15	10.66 (71)	10.02 (67)	8.00 (58)
Lys	45	21.64 (48)	17.08 (38)	21.90 (49)
SCA	22	16.52 (75)	7.10 (32)	16.80 (77)
AAA	38	5.59 (15)	3.87 (10)	5.21 (14)

*- model WHO/FAO/UNU (2007)

SCA-sulfur containing amino acids (Phe + Tyr)

AAA-aromatic amino acids (Met + Cys)

The assumed amino acid score showed that biological value or the anticipated ability absorbed protein from game animals' meat to fulfill human amino acid requirements is high.

IV. CONCLUSIONS

1. Protein content in samples of game meat were detected 20.88 - 22.05%, richest were samples of roe deer meat it did not differ significantly among game meat species.
2. Game meat should be classified as high quality meat from connective tissue point of view.
3. The sum of essential amino acids in game meat samples were determined from 7.05–8.26g100g⁻¹
4. The assumed amino acid score showed that biological value or the anticipated ability absorbed protein from game animals' meat to fulfill human amino acid requirements is high.

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