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Nutritional Quality (Bioavailability) of Elk Meat in the Biogeochemical Zones of the Sakha Republic (Yakutia)

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ABSTRACT: In the northern part of the Republic of Sakha (Yakutia), the main source of food is the meat of game animals. Particular attention is given to the biochemical zones of the necessary chemical elements in the environment and the food chain, the presence of which depends on the quality of the products obtained from wild game animals. Wild animals occupy territories not developed by agricultural production, use wood and herbaceous plants for food, which do not require maintenance and special care, and provide high-quality delicacy products, thereby playing an important role. For the local peoples of Yakutia, elk meat is one of the main sources of nutrition and survival and replenishment of the body with necessary nutrients and vitamins. Thus, the data obtained show that elk meat is a rich source of the vital macro- and microelements, the content of which depends on the characteristics of nutrition and the habitat and metabolism of elk living in the harsh conditions of the Far North. Also, in the biogeochemical zones of the Republic of Sakha (Yakutia), elk meat contains a well-balanced complex of biologically active substances, which includes the amino acid composition, vitamins and mineral elements. It refers to a complete nutritional protein product.

Keywords: Elk, Essential Amino Acids, Macro elements, Meat Composition, Microelements, Nonessential Amino Acids, Yakutia, Vitamins.

I. INTRODUCTION

Elk is the largest representative of the family Cervidae of the East Siberian subspecies Yakutia elk (*Alces* a. *Pfizen-mayeri* Zukowski) [1, 2]. In recent years, elk population in the Far North was small. For indigenous communities of the Sakha Republic (Yakutia), elk meat is one of the main sources of nutrition (essential nutrients and vitamins). Wild animals occupy territories that are not cultivated and feed on woody and herbaceous plants (which do not require premises for maintenance and special care) and provide high-quality specialty foods. Game meat is a high-value, nutritious, and dietary product. Compared to butcher's meat, game meat contains more bioactive substances for normal human life and is also abundant in vitamins and minerals that are most important for humans [3-15]. Studying elk meat in the biogeochemical zones of the Republic of Sakha (Yakutia) will allow determining a balanced complex of biologically active substances that reflects the amino acid composition, vitamins and mineral elements.

II. MATERIALS AND METHODS

The study was conducted at the Department of Veterinary Sanitary Evaluation and Hygiene of the Yakutsk State Agricultural Academy and the Yakutia Republican Veterinary Testing Laboratory of the Republic of Sakha (Yakutia).
The research material was the carcasses and organs of wild elks (35 animals) that were shot in the northern, north-eastern, and southern zones of the Republic of Sakha (Yakutia) [8]. Samples were collected from different age groups in biogeochemical zones: adults and young animals. Climatic-geographical zones were selected with regard to the features of the territory of the republic in three biogeochemical zones: north (including the polar and circumpolar zones), northeast, and south.

III. RESULTS AND DISCUSSION

The *north biogeochemical zone* occupies one of the most extensive territories of Yakutia and includes the polar and circumpolar zones extending from the Arctic coast. The climate of the region is arctic and subarctic due to the influence of the Arctic Ocean. The mining industry is developed in six districts of this zone.
The *south biogeochemical zone* occupies the southern and southwestern areas of the republic. Gold, coal and other minerals are mined in the south zone. The pH value in meat was considered to study the effect of the pre-slaughter state of the animal on the vitamins content.

The quality of nutrition product is characterized not only by the proteins-fats ratio, but also by the content of vitamins, which largely determines the biological value of meat.
In the regions of the Republic of Sakha (Yakutia), the main source of vitamins is meat. It is the vitamins in elk meat mined in different regions of the Republic of Sakha (Yakutia) that differ in the quantitative and qualitative composition of vital vitamins depending on age.

Table 1: Vitamin content in elk meat in different biogeochemical zones, mg%.

S.No.	Age	Vitamin A	Vitamin B_1	Vitamin B_2	Vitamin B_{12}	Vitamin PP
North zone						
pH 5.6-6.0						
1.	adult	16.86±0.52	0.93±0.17	0.75±0.05	5.17±0.12	18.24±0.05
2.	young	21.84±0.12	1.0±0.01	0.91±0.05	5.65±0.08	18.62±0.36
pH 6.6-6.8						
3.	adult	12.37±0.4	0.38±0.01	0.35±0.03	4.0±0.1	15.44±0.01
4.	young	17.54±0.5	0.67±0.02	0.59±0.05	4.28±0.1	16.12±0.2
Northeastzone						
pH 5.6-6.0						
5.	adult	17.21±0.52	1.14±0.17	0.86±0.05	5.72±0.12	19.13±0.05
6.	young	22.53±0.12	1.36±0.01	0.98±0.05	5.91±0.08	19.42±0.36
pH 6.6-6.8						
7.	adult	13.25±0.4	0.45±0.01	0.42±0.03	4.53±0.1	16.75±0.01
8.	young	18.63±0.5	0.74±0.02	0.65±0.05	4.81±0.1	17.38±0.2
Southzone						
pH 5.6-6.0						
9.	adult	16.14±0.52	0.89±0.17	0.68±0.05	5.01±0.12	18.14±0.05
10.	young	21.06±0.12	0.91±0.01	0.76±0.05	5.52±0.08	18.51±0.36
pH 6.6-6.8						
11.	adult	11.95±0.4	0.23±0.01	0.22±0.03	4.0±0.1	15.4±0.01
12.	young	16.83±0.5	0.56±0.02	0.48±0.05	4.2±0.1	16.1±0.2

Table 1 shows that elk meat contains 16.8 mg% of vitamin A. The vitamin A content in elk meat depends on the condition of the animal before it was shot. This is due to the fact that with prolonged pursuit, as a result of which the animal becomes exhausted, the metabolism increases, the pH of the meat rises (6.6-6.8), and the amount of vitamin A decreases to 12.3 mg%. The high content of vitamin A was found in young animals (21.8 mg%), which is one of the factors determining growth and development.

High content of thiamine and riboflavin (0.9-1.0 mg%, 0.75-0.9 mg %) was also observed. The amount of thiamine and riboflavin decreases to 0.3-0.6 mg% when the animal becomes exhausted before being shot.

The content of vitamin B_{12} in meat was 5.1-5.6 mg%; at pH 6.6-6.8, its level decreased to 4.0 mg%. Nicotinic acid is found in elk meat at a fairly high level, since it is widely distributed in plants elks generally eat.

According to a study of the Taimyr elk population, the total level of fat-and water-soluble vitamins is 60.83 mg/ kg. A high content of E, B5 and B3 vitamins is noted [1]. Consequently, the vitamin content in elk meat depends on the age and especially on the pre-slaughter state of the animal.

The biological value of meat is directly dependent on the methods of elk hunting, as the meat of the elk shot in a calm state contains more vitamins than the meat of an exhausted animal.

Table 2: The content of macroelements and microelements in elk meat in different biogeochemical zones, mg%.

S.No.	Elements	North zone	Northeastzone	Southzone
1.	Calcium	18.8±1.4	18.3±1.4	19.2±1.5
2.	Phosphorus	221±15	219±14	226±16
3.	Potassium	320±24	329±28	325±26
4.	Ferrum	7.1±0.62	7.9±0.64	8.7±0.76
5.	Copper	2.3±0.15	1.9±0.12	1.2±0.1
6.	Zinc	4.6±0.37	5.8±0.46	4.1±0.32
7.	Manganese	145±12	149±13	154±15
8.	Cobalt	3.6±0.28	3.2±0.24	4.3±0.31

The research showed that the content of macroelements and microelements in the elk muscle tissue varied in different biogeochemical zones. The content of calcium (19.2 ± 1.5 mg%) and phosphorus (226 ± 16 mg%) in elk meat from the south biogeochemical zone was higher than in meat from the north and northeast zone, and the highest content of potassium (329 ± 28 mg%) was observed in the northeast biogeochemical zone (Table 2).

Among the microelements, the content of iron (8.7 ± 0.76 mg%), manganese (154 ± 15 mg%) and cobalt (4.3 ± 0.31 mg%) was higher in the southern biogeochemical zone, of copper (2.3 ± 0.15 mg%) – in the northernbiogeochemical zone, of zinc (5.8 ± 0.46 mg%) - in the north-eastern biogeochemical zone.

Regarding the content of mineral elements in the meat of wild ungulates of the Yenisei North, it has been found that elk meat (13.50 g/ kg) exceeds the meat of reindeer and musk ox in terms of potassium content [2].

Proteins are an important component that determines the nutritional value of meat. Of great importance is not only the total amount of proteins in meat, but also their amino-acid composition, since the composition of proteins determines the nutritional value of meat and the amino-acid content determines the biological value of meat. Meat is a valuable source of amino acids, including essential amino acids. Table 3 shows that the quantitative composition of essential and non-essential amino acids differs in the biogeochemical zones of the Republic of Sakha (Yakutia).

Chilled meat of adult specimens had more aspartic acid (north – 13.1 mg%, northeast – 13.9 mg%, south – 13.2 mg%), glutamic acids (north – 14.3 mg%, northeast – 14.6 mg%, south – 13.7 mg%), leucine (north – 11.2 mg%, northeast – 12.1 mg%, south – 10.2 mg%), arginine (north – 11.6 mg%, northeast – 12.4 mg%, south – 11.2 mg%). There was also a small amount of alanine (north – 9.7 mg%, northeast – 10.5 mg%, south – 9.2 mg%), glycine (north –9.4 mg%, northeast – 10.1 mg%, south – 9.5 mg%), valine (north – 8.8 mg%, northeast – 9.2 mg%, south – 8.2 mg%), lysine (north – 8.5 mg%, northeast – 9.3 mg%, south – 8.1 mg%). Similar values were observed in chilled meat of young animals. However, the content of certain essential amino acids (lysine, phenylananine), as well as some nonessential amino acids (arginine, histidine, glutamic acid), in the meat of young animals was higher compared with the meat of adults.

We could not isolate methionine and tryptophan in a free form from chilled meat of adult and young elks from all three biogeochemical zones. Freezing of meat does not stop the accumulation of amino acids in it, however, quantitative changes occur differently. After freezing of chilled meat of adults and young animals to a temperature of –9 ℃, the amount of leucine, phenylalanine, and glutamic acid in it noticeably increased. At the same time, the amount of valine, threonine, alinine, argeinin, aspartic acid, histidine, and glycine increased only slightly. Small amounts of methionine and tryptophan were found in meat. The accumulation time of amino acids to some extent also depends on the pre-slaughter state of animals.

Table 3: The amino acid content in elk meat, mg%.

S.No.	Aminoacid	North zone				Northeastzone				Southzone			
		Chilledmeat		Fresh frozenmeat		Chilledmeat		Fresh frozenmeat		Chilledmeat		Fresh frozenmeat	
		adult	young	adult	young	adult	young	adult	young	adult	young	adult	young
Essential amino acids													
1.	Valine	9.16	9.47	9.72	10.02	9.23	9.66	9.98	10.14	8.91	9.24	9.46	9.82
2.	Isoleucine	7.95	8.23	8.54	8.96	8.12	8.53	8.91	9.12	7.83	8.14	8.38	8.76
3.	Leucine	12.01	12.18	12.84	13.21	12.8	12.26	13.04	13.35	11.86	12.03	12.65	13.14
4.	Lysine	9.18	10.46	10.08	11.52	9.32	10.67	10.23	11.64	9.15	10.42	9.97	11.46
5.	Methionine	-	-	2.11	2.23	-	-	2.12	2.28	-	-	1.87	2.03
6.	Threonine	6.54	6.81	7.12	7.67	6.74	6.91	7.26	7.89	6.46	6.75	7.01	7.52
7.	Tryptophan	-	-	2.24	2.42	-	-	2.39	2.47	-	-	2.18	2.34
8.	Phenylalanine	7.75	8.24	8.36	9.09	7.81	8.42	8.51	9.21	7.63	8.09	8.15	8.89
9.	Cystine	-	-	-	-	-	-	-	-	-	-	-	-
Total amount		52.59	55.39	61.01	65.12	53.4	56.45	62.44	66.1	51.84	54.67	59.67	63.96
Nonessentialaminoacids													
10	Alanine	12.15	12.88	12.34	13.12	12.14	12.82	12.29	13.07	12.17	12.91	12.39	13.21
11	Arginine	11.28	13.43	13.72	14.02	11.34	13.64	13.82	14.13	11.16	13.28	13.58	13.88
12	Asparticacid	13.56	13.67	14.89	15.18	13.71	13.89	15.11	15.36	13.82	13.90	15.16	15.43
13	Histidine	5.67	6.12	6.35	6.88	5.93	6.29	6.57	7.08	5.58	6.06	6.24	6.72
14	Glycine	10.03	10.27	10.93	11.09	10.18	10.32	11.03	11.15	10.04	10.31	10.98	11.15
15	Glutamicacid	14.57	15.03	15.07	16.11	14.61	15.14	15.38	16.21	14.35	14.89	14.87	15.97
16	Serine	7.19	7.40	7.95	8.22	7.25	7.67	8.07	8.34	7.15	7.37	7.90	8.16
17	Tyrosine	8.22	8.29	8.64	8.78	8.42	8.59	8.81	8.97	8.23	8.34	8.68	8.82
Total amount		82.65	87.09	89.89	93.4	83.58	88.36	91.08	94.31	82.5	87.06	89.8	93.34

The highest total amount of essential and nonessential amino acids in chilled elk meat was found in the south biogeochemical zone (43.8 mg%, 71.9 mg%, respectively). The lowest content of nonessential amino acids in chilled meat of young animals was found in the north biogeochemical zone (70.3 mg%). The highest content of essential and nonessential amino acids in frozen meat of adult animals was observed in the north biogeochemical zone (62 mg%, 89.3 mg%, respectively), and the lowest content of essential and nonessential amino acids was found in the southbiogeo chemical zone (55.2 mg%, 79.2 mg%, respectively). Studies showed qualitative and quantitative differences in the amino acid composition in muscle tissue of adults and young elks in different biogeochemical zones. This indicates disruptions in the ratio of amino acids in the meat where there is intense environmental pollution as a result of the operation of large industrial complexes.

IV. CONCLUSION

The results show that elk meat is abundant in vital macro- and microelements, the content of which depends on the habitat, the characteristics of the diet, and metabolism of the elks that live in the harsh conditions of the Far North. Elk meat in the biogeochemical zones of the Republic of Sakha (Yakutia) contains a well-balanced complex of biologically active substances, which includes amino acids, vitamins, and mineral elements. Elk meat is a complete nutritious protein product.

In conclusion, it should be noted that the research data will be further used for assessment of the nutritional (biological) value of elk meat in the biogeochemical zones of the Republic of Sakha (Yakutia).

Conflict of Interest. There are no conflicts of interest to declare.

REFERENCES

[1]. Kaizer, A.A., Begletsov, O.A., Martsekha, E.V., and Kaizer, G.A. (2013). Qualitative composition of elk meat (*Alces* a. *Pfizenmayeri* Zukowski) of the Taimyr population. *Achievements of science and technology of the agro-industrial complex. Moscow, 12*: 72-73.

[2]. Martsekha, E.V., Gnedov, A.A., and Kaizer, A.A. (2015).Comparative characteristics of biochemical parameters of meat of wild ungulate animals of the Yenisei North. *Proceedings of the educational institution «Vitebsk State Academy of Veterinary Medicine». Vitebsk, 51*(2): 142-146.
[3]. Chirich, E.G. and Babina, M.P. (2014). The study of the chemical composition and nutritional value of wild game meat. *Transactions of an educational institution «Vitebsk «Order Badge of honor» of the State Academy of Veterinary Medicine». Vitebsk, 50*(1): 202-204.
[4]. Kaznacheev, V.P. (1979). Adaptation of humans to the extreme conditions of the North. Socio-economic aspects of environmental management in the North of Siberia. *Yakutsk*, 99-118.
[5]. Fedorov, V.I., Sleptsov, E.S., Vinokurov, N.V., Grigoriev, I.I., Zakharova, O.I., and Maksimova, A.N. (2018). On Adapting Domestic Even Reindeer to the Mountain-Taiga Zone of The North-East of Russia. *Journal of Pharmaceutical Sciences and Research, 10*(7): 1660-1662.
[6]. Fedorov, V.I., Stepanov, A.I., Sleptsov, E.S., Vinokurov, N.V., Bochkarev, I.I., and Maksimova, A.N. (2018). Northern Domestic Reindeer Husbandry of the Republic of Sakha (Yakutia): Retrospective Analysis and Development Trends. *Journal of Pharmaceutical Sciences and Research, 10*(10): 2559-2563.
[7]. Sleptsov, E.S., Vinokurov, N.V., Stepanov, A.I., Fedorov, V. I., Robbek, N.S., and Maksimova, A.N. (2018). Structure and biological properties of artificial vaccinating compounds for treating brucellosis in agricultural animals. *International Journal of Pharmaceutical Research, 10*(4): 766-770.
[8]. Sidorov, M.N. and Tomashevskaya, E.P. (2019). The chemical composition and energy value of elk meat in the biogeochemical provinces of the Republic of Sakha (Yakutia).*Bulletin of the Irkutsk State Agricultural Academy, 90*: 149-155.
[9].Bulganin, M., Subhrajit, B., Udipta, C., and Kaushik, M. (2017). An update on the Diversity, Distribution and Zoo-geographical notes on Longhorn Beetles (Cerambycidae: Coleoptera) of North-East India. *Biological Forum – An International Journal, 9*(2): 61-80.
[10].Adesh, K. and Amita, K. (2017). A Comparative Study on Avifaunal Diversity, Threats and Conservational Requirements of Wetlands of Uttar Pradesh. *Biological Forum – An International Journal, 9*(2): 107-113.
[11]. Sherene, T. (2017). Role of Soil Enzymes in Nutrient Transformation: A Review. *Bio Bulletin, 3*(1): 109-131.
[12]. Ateria, G., Khadder, V., and Phadnis, S. (2015). Survey and characterization of fluoride in drinking waters in Jhabua district of Madhya Pradesh. *Biological Forum – An International Journal, 7*(2): 461-466.
[13]. Sharma, G., Kumar, S., Dhatwalia, N., and Ram, K. (2019). Studies on the Mammalian Diversity of Lahaul valley, District Lahaul and Spiti, Himachal Pradesh, India with their Conservation status. *Biological Forum – An International Journal, 11*(2): 150-156.
[14]. Ghosh, R., Tarafdar, A., Chobe, D., Chandran, U., and Sharma, M. (2019). Diagnostic Techniques of Soil Borne Plant Diseases: Recent Advances and Next Generation Evolutionary Trends. *Biological Forum – An International Journal, 11*(2): 01-13.
[15]. Ramzan, S., Zahoor, I., Ahmad, P., Ashraf, I., Wani, M., and Rasool, R. (2019). Effect of Agricultural Land-use on Carbon Sequestration in Soils. *Biological Forum – An International Journal, 11*(1): 117-125.

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