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Amino Acid Composition of Beef near The Former Semipalatinsk Nuclear Test Site.

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ABSTRACT

Amino acid content in beef sampled from different settlements, which are situated around the Semipalatinsk nuclear test site (SNTS), was determined. These settlements belong to radiation risk zones affected by nuclear bomb testing on SNTS for 40 years. The results showed that the total amount of essential and non-essential amino acids were lower in all samples comparing with the FAO/WHO scale.

Keywords: amino acids, beef, Semipalatinsk nuclear test site, radiation.

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INTRODUCTION

Environmental protection is one of the most urgent problems of humanity. Ecology and Environmental Problems occupy an important place in the socio-economic programs in developed and developing countries [1].

Semipalatinsk nuclear test site (SNTS) is one of the largest sites for nuclear testing located in the north-eastern part of Kazakhstan, in the steppe and semi-desert zone, with an area of about 18,500 square meters. km [2]. The first nuclear explosion at SNTS was conducted on August 29, 1949. On August 12, 1953 first thermonuclear device was tested at the site, and on November 22, 1955 - the hydrogen bomb was tested as well. From 1949 to 1989 years in its territory a total of 468 nuclear explosions was conducted, including atmospheric 125 (26 surface, 91 air, altitude 8); 343 nuclear test explosions under the ground (215 of them in the galleries, and 128 wells) [3]. Tests were conducted with different power devices, at different depths and in various rock formations. High-energy institute of Academy of Sciences of Kazakhstan estimated that the total capacity of nuclear weapons tested in the atmosphere and the ground SNTS (in populated areas) is 2.5 thousand times more powerful than the bomb dropped on Hiroshima in 1945. The consequences of nuclear testing are tragic. Populations' health in districts adjacent to the Semipalatinsk region suffers from irreparable harm. Radiation exposure has led to a sharp weakening of the immune system, which increases the number of diseases; exacerbate the course and duration of disease. People suffered from radiation exposure are tending to have more cases of malignancies. Anemia, unusual skin lesions, disorders of blood pressure, blood vessels and pathology, premature aging, mental illness, suicide are considered to be a sad legacy of the landfill. [4]

The landfill of site covers an area of the East Kazakhstan (54%), Pavlodar (39%) and Karaganda (7%) regions. Resolution of the Government of the Republic of Kazakhstan № 172 dated 07.02.1996, the land of the former Semipalatinsk nuclear test site translated into the reserve land: Karaganda region - 131.7 thousand hectares, Pavlodar - 706 hectares, the East Kazakhstan - 978.9 thousand hectares [5].

The region does not exercise effective control of radiological contamination of products grown in the vicinity of the landfill. Land use is carried out spontaneously and environmental effects of nuclear testing and related activities still affect agriculture and economy of the region and threaten the health of the population [6].

Uncontrolled agricultural activities on the territory of SNTS are one of the most important problems, since the transfer of radionuclides in the chain soil-plant-animal is related to their entry into the human body [7].

Meat and meat products in Kazakhstan have a special place, as they have historically been one of the main national products. Meat products play an important role in the human diet, as they are a source of protein needed for vital functions [8].

Beef is an excellent nutritional value, as it has high biological value protein, it is rich in vitamins, especially B-complex, and this is due to a high content of minerals, especially iron. The beef contains all the amino acids necessary for the human body [9].

If the animal takes more than 80% of cesium-137, it is accumulated in the muscles and having higher radiotoxicity leads to uniform exposure of organs and tissues. Strontium-90 accumulates in the bone, exposing to chronic irradiation of bone marrow and organs of hematopoiesis [10].

The goal of this study was to determine of the content of amino acids in beef in several areas of the radiation risk of the former Semipalatinsk Nuclear Testing Site.

MATERIALS AND METHODS

The samples were collected from the settlements, which are situated around the SNTS - Sarzhal, Akzhar, Novopokrovka and Karatau (fig.1).

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- Sarzhal, located on the territory of the former Semipalatinsk Nuclear Testing Site is 25 km., Refers to the area of emergency radiation risk.
- Akzhar, Pavlodar region is located on the territory of the former SNTS 80 km., Belongs to the zone of maximum radiation risk.
- Novopokrovka, Borodulikha district is located on the territory of the former Semipalatinsk Nuclear Testing Site 165 km., Refers to the increased radiation risk.
- Karatau is located on the territory of the former Semipalatinsk Nuclear Testing Site 120 km., From the city of Karaganda, 250 km. It refers to the minimum radiation risk.

The object of the study was a beef from the lean parts of the carcass.

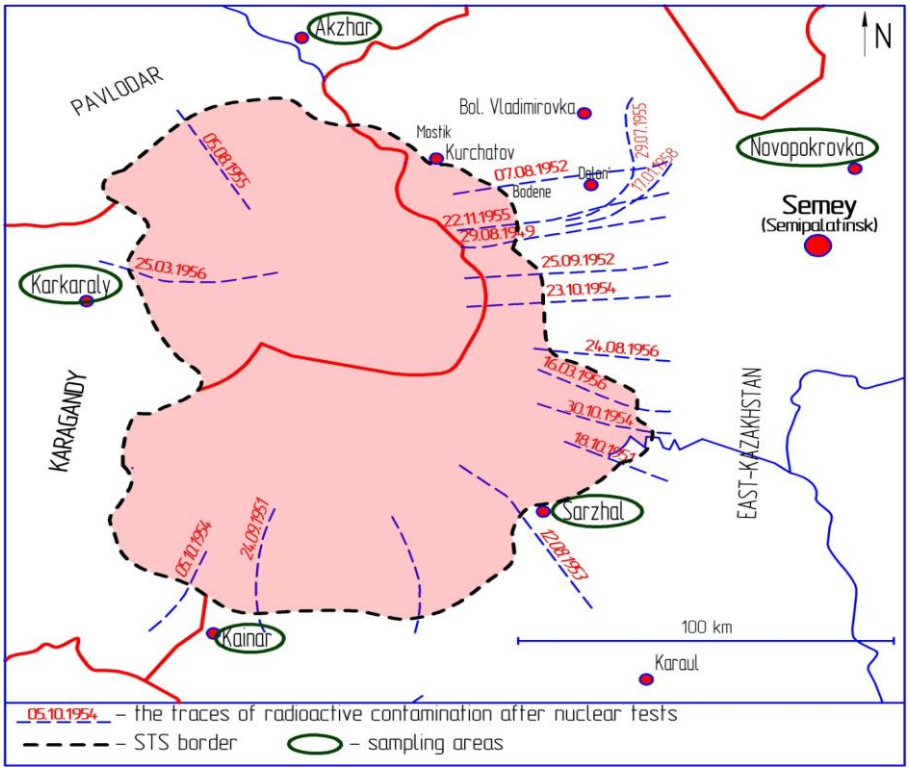

Figure 1: Sampling locations (circled) with respect to the SNTS

Samples of meat (lean beef from the dorsal part) were selected in accordance with GOST 51477-99 [11]. Physical and chemical analysis of beef was carried out under standard and conventional techniques: Contents of amino acids were determined according to GOST 13496.21-87 [12], GOST 32195-2013 [13].

Amino acids were also determined by liquid chromatographer «LC-20 Prominence» with fluorometric and spectrophotometric detector. We used the chromatographic column size 250 × 4,6 mm «Supeclo C 18, 5 um" with precolumn. The chromatographic analysis was carried out in gradient mode, eluent at a flow rate of 1.2 ml / min. column thermostat and a temperature of 40 ° C. The measurement was performed by high performance liquid chromatography on a converted phase with spectrophotometric and fluorometric detector at wavelengths of 246 and 260 nm using acid hydrolysis and amino acid modifications with phenyl isothiocyanate solution in isopropyl alcohol to give phenyltiogidant. The mobile phase used a mixture of 6.0 M CH3COONa solution at pH 5.5, 1% isopropyl alcohol in acetonitrile and a solution of 6.0 M CH3COONa solution at pH 4.05. Terms of acid hydrolysis of samples during sample preparation procedures were optimized. Standard amino acids («Sigma Aldrich») samples, acetonitrile, isopropyl alcohol, phenyl isothiocyanate («Sigma Aldrich»), sodium acetate, hydrochloric acid and sodium hydroxide of high purity were used.

For carrying out the hydrolysis 100 mg of sample was places in glass ampoules with drawn ends. Next step was adding of 10 ml of 6 M hydrochloric acid solution. The mixture was thoroughly stirred and blown with stream of nitrogen for 2 min. Glass ampoules were sealed and placed in an incubator. The hydrolysis is carried

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out at a temperature of 110 ° C for 24 hours. Aliquots were dried at 65 ° C in a stream of air. Dried aliquots were added with 0.1 ml of 0.15 M NaOH solution and mixed thoroughly. Then 0.35 ml of phenyl isothiocyanate poured into isopropyl alcohol solution, stirred, and added 0.05 ml of distilled water and filtered through a membrane filter with a pore diameter of 0.45 microns. The resulting solutions were subjected to chromatographic analysis.

The concentration of amino acids in the samples was calculated per 100 g of dry matter according to formula 2:

$$X = \frac{C \times S_r \times V}{S_{CT} \times m} \quad (2)$$

where, Cr - amino acid concentration in the working standard solution, mg / ml;
V - final volume of hydrolyzate ml;
Sr - peak area of an amino acid in the test sample;
Sst - peak area of the standard amino acid working solution;
m - mass of sample taken on hydrolysis mg;
X - concentration of vitamins in the samples, mg / 100 g dry matter.

RESULTS AND DISCUSSION

The research results of the amino acid and vitamin beef composition are of beef shown in Table 1.

Table 1: Amino acid composition of beef

Amino acid	Scale FAO/WHO, mg/100g	Sampling locations			
		Sarzhal, mg/100g	Akzhar, mg/100g	Novopokrovka, mg/100g	Karatau, mg/100g
Essential amino acids	8093	6729±0,11	7112±0,001	7192±0,006	6905±0,0015
Valine	1148	975±0,003	1026±0,02	1046±0,01	1032±0,017
Isoleucine	939	751±0,011	785±0,07	791±0,06	767±0,011
Leucine	1624	1373±0,011	1466±0,03	1487±0,02	1421±0,012
Lysine	1742	1492±0,014	1584±0,06	1594±0,06	1513±0,011
Methionine	588	388±0,046	448±0,07	449±0,05	408±0,027
Threonine	875	765±0,008	801±0,03	808±0,05	796±0,035
Tryptophan	273	198±0,23	210±0,14	219±0,07	213±0,05
Phenylalaine	904	787±0,038	792±0,08	798±0,06	755±0,012
Non-essential amino acids	12967	11449,2±0,05	11089±0,004	11002±0,001	10834±0,0017
Alanine	1365	1142±0,07	1091±0,04	1083±0,04	1067±0,031
Arginine	1296	1071±0,06	1043±0,02	1038±0,02	1013±0,043
Aspartic	2326	1807±0,009	1768±0,04	1761±0,01	1702±0,01
Histidine	769	719±0,05	717±0,018	712±0,03	697±0,07
Glycine	878	992±0,04	940±0,04	933±0,03	908±0,025
Glutamic	3603	3115±0,03	3064±0,02	3061±0,01	3058±0,005
Hydroxyproline	58	81,2±0,16	62±0,17	51±0,24	48±0,079
Proline	658	741±0,06	687±0,10	680±0,10	672±0,045
Serine	904	833±0,02	781±0,08	763±0,06	758±0,014
Tyrosine	800	691±0,09	665±0,06	652±0,06	648±0,017
Cystine	310	257±0,17	271±0,09	268±0,19	263±0,022
Sum of amino acids	21060	18387,2±0,003	18201±0,005	18194±0,001	17739±0,0013

From the table 1, the amount of amino acids in beef from the village Sarzhal was 87.3% of FAO/WHO scale; including essential amino acids 83.1%; non-essential - 88.3%.

The individual amount of essential amino acids: valine 87.9% 12.1% less than the norm; isoleucine 79.9% to 20.1% less than the norm; Leucine 84.5% to 15.5% less than the norm; lysine 85.6% to 14.4% less;

methionine 65.9% to 34.1% less than the norm; threonine 87.4% to 12.6% less than the norm; Tryptophan 72.5% to 27.5% less than the norm; phenylalanine 87% to 13% less than normal.

The number of non-essential amino acids in comparison with FAO/WHO scale norm was: alanine decreased by 16.4%; arginine at least 17.4%; aspartic acid is less than 22.4%; histidine less than 6.6%; glycine greater by 2.9%; glutamic acid is less than 13.6%; hydroxyproline 40% more; proline more at 12.6%; serine at least 7.9%; tyrosine less than 13.7%; cystine decreased by 17.1%.

The amount of amino acids in beef from the village of Akzhar amounted to 86.4%; including essential amino acids, 87.8%; non-essential 87.3%. Separately, essential amino acids' difference is: valine decreased by 10.7%; isoleucine at least 16.5%; leucine is less than 9.8%; lysine decreased by 9.1%; methionine to less than 23.9%; threonine 8.5% less; tryptophan is less by 23.1%; phenylalanine lower by 12.4%.

The content of essential amino acids in comparison with the norm is: alanine decreased by 20.1%; arginine decreased by 19.6%; aspartic acid is less than 24%; histidine less than 6.8%; glycine greater by 7%; glutamic acid is less than 15%; Hydroxyproline more than 6.8%; proline more at 4.4%; serine less than 13.7%; tyrosine less than 16.9%; cystine less than 12.6%.

The amount of amino acids in beef in v. Novopokrovka was 86.4%; including essential amino acids 88.8%; non-essential 84.8%. Separately, essential amino acids difference is: valine decreased by 8.9%; isoleucine is less than 15.8%; leucine at least 8.5%; lysine to less than 8.5%; methionine decreased by 23.7%; threonine less than 7.7%; tryptophan at least 19.8%; phenylalanine lower by 11.8%.

The content of essential amino acids in comparison with the norm is: alanine decreased by 20.7%; arginine at least 20%; aspartic acid is less than 24.3%; histidine at least 7.5%; glycine greater by 6.2%; glutamic acid is less than 15.1%; hydroxyproline decreased by 12.1%; more than 3.3% of proline; serine less than 15.6%; tyrosine less than 18.5%; cystine decreased by 13.6%.

The amount of amino acids in beef from the village Karatau was 84.2%; including essential amino acids 85.3%; non-essential 83.5%. The amount of amino acids in beef below the norm by 15.8%; essential amino acids less than 14.7%; Interchangeable lower by 16.5%.

Separately, essential amino acids are less than normal: valine 10.2%; isoleucine by 18.4%; leucine to 12.5%; lysine 13.2%; methionine at 30.6%; threonine by 9.1%; tryptophan 21.98%; phenylalanine 16.5%.

Difference of essential amino acids as compared to the norm is: alanine decreased by 21.8%; arginine decreased by 21.8%; aspartic acid is less than 26.8%; histidine less than 9.4%; glycine, 3.4% greater; glutamic acid is less than 15.2%; hydroxyproline decreased by 17.3%; proline more at 2.1%; serine less than 16.2%; tyrosine at least 19%; cystine less than 15.2%.

CONCLUSION

The amount of amino acids in beef from the village Sarzhal was 87.3%; Akzhar village was 86.4%; Novopokrovka village was 86.4%; Karatau village was 84.2%.

The problem of production of ecologically safe and biologically high-grade production of livestock, in terms of the former Semipalatinsk Nuclear Testing Site is one of the most pressing nowadays. So it directly affects the quality of food and the human environment, so closely links the problems of ecology, veterinary medicine and public health.

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