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A. N. Nikitenko¹, V. I. Domash², A. Ch. Sheyko¹¹Belarusian State Technological University²Institute of Experimental Botany named after V. F. Kuprevich
of the National Academy of Sciences of Belarus**RESEARCH OF AMINO ACID COMPOSITION OF PROTEIN OF CEREAL
AND GRAIN LEGUME CROPS OF BELARUSIAN SELECTION**

In the article presents the results of studies of protein content and amino acid composition of grains and grain legume crops, cultivated on the territory of the Republic of Belarus. The objects of study were yellow lupine varieties Academichesky, BSHA-382, Bistrorastuschy 4, Kastrychnik, Narochansky, blue lupine varieties Nemchinovsky, Frost, Danko, pea varieties Ramonsky, Aist, Malinovka, oat of Bug varieties, Los-3, Nemchinovsky, Erbgraf, Endskurt, oat varieties of Zhodinsky, Krynica, Favorit, Yanka varieties. In these sorts we determined the content of protein, essential and non-essential amino acids, estimated of biological value of protein grains and legumes by amino acid score method allowed us to recommend Kastrychnik, Narochansky yellow lupine, Nemchinovsky blue lupine, Zhodinsky spring barley, Nemchinovsky and Erbgraf oats varieties for use in the form for feed of animal and raw materials for the industrial manufacture of products.

Key words: protein, amino acid, aminoanalyser, yellow lupine, blue lupine, pea, oats, barley, animal feed.

Introduction. The exceptional utility of the vegetable protein lies in its important role in the formation of the cell structure, promoting the growth and development of living organisms. One aspect of the study of plant proteins is the qualitative analysis of the raw materials, which is aimed at finding the ways to eliminate protein deficiency and to increase the biological value of protein to satisfy the needs of animals and people more fully.

Based on experimental studies of the protein structure of the majority of crop species, carried out by Belarusian and foreign scientists, a database was formed in order to conduct further practical work in crop and industrial production.

Cereals and grain legumes are an important group of cultivated plants in the agro-industrial complex of Belarus. They are a source of raw materials for a number of industries. The modern selection of cereals and legumes is aimed at increasing the productivity and stability of plants to diseases, whereas amino acid composition of protein is not given so much attention [1]. However, quantitative and qualitative composition of protein determines the nutritional value of cultivars [2].

Main part. The aim of this work was to study the protein content, the quantitative and qualitative amino acids composition of cereals and grain legume crops, cultivated on the territory of the Republic of Belarus.

The objects of study were grain legumes:

– yellow lupine Academichesky, BSHA-382, Bistrorastuschy 4, Kastrychnik, Narochansky varieties, used as a high-value protein feed;

– blue lupine Nemchinovsky, Frost, Danko, Kupala varieties, incl. applied in the food indus-

try for enrichment of bread, pasta and confectionery;

– pea Ramonsky, Aist, Malinovka varieties.

Also, the amino acid composition of cereal proteins has been studied:

– oat Bug, Los-3, Nemchinovsky, Erbgraf, Endskurt varieties, which are used in animal feed and food industries;

– barley Zhodinsky, Krynica, Favorit, Yanka varieties, which provide a high proportion of feed protein in Belarus.

The protein content was determined by Kjeldahl method, amount of total nitrogen was established and conversion factors were used: 5.70 – for cereals and 6.25 – for legumes [3].

Preparation of samples for research on amino acid composition included the following steps:

– weighing the investigated seeds sample in a round bottom flask of 1,000 cm³;

– adding 800 cm³ of 6N solution HCl;

– heating the sample with reflux in an oil bath for 24 hours at a temperature of 110°C, creating an environment to prevent oxidation;

– cooling and filtering the sample;

– removal of water on a rotary evaporator at a temperature not exceeding 60°C;

– wet residue dissolved in 20 cm³ of distilled water and the repeated removal of water (2 times);

– dilution of residue in 50 cm³ of buffer solution.

Protein aminoanalyzer “Arakus” (Germany) was used for determining the amino acids content in terms of total protein. The method is based on chromatographic analysis of protein hydro lysates by stepper gradient elution and subsequent post

column reaction with ninhydrin. The photometric detection was performed with the help of a photometric detector at a wavelength of 570 nm for all amino acids except proline, which is measured at a wavelength of 440 nm.

The biological value of plant protein was evaluated by calculating the amino acid score of detected amino acids [2].

The results of studies of protein content and amino acids composition in various cereal and grain legumes are shown in Table 1 and 2.

As can be seen from the data presented in Table 1, the highest protein content was found in the yellow lupine varieties Academichesky and Kastrychnik and

blue lupine varieties Nemchinovsky and Kupala. The content of essential amino acids ranged from 27.3 to 35.5% total protein in varieties of yellow lupine, and ranged from 26.2 to 28.5% in blue lupine varieties. The content of amino acids in yellow lupine seed samples was 64.5–72.7%, in blue lupine – 71.5–73.8% of all proteinogenic amino acids.

Based on the data presented in Table 2, it should be concluded that varieties of peas Ramonsky and Aist contained the highest amount of protein. The content of essential amino acids in the test pea varieties ranged from 28.5 to 33.1% of all amino acids and the number of nonessential amino acids – 66.9–71.5%.

Table 1

Protein and amino acid content in grain legume crops

Varieties	Protein, %		Amino acid content in terms of protein, %	
	Average	Result of research	Essential	Nonessential
Yellow lupine				
Academichesky	34.4	35.6	31.2	68.8
BSHA-382		33.2	27.3	72.7
Bistorastuschy 4		34.0	27.6	72.4
Kastrychnik		36.7	28.9	71.1
Narochansky		32.3	35.5	64.5
Blue lupine				
Nemchinovsky	33.7	34.5	28.1	71.9
Frost		30.6	27.2	72.8
Danko		32.2	28.5	71.5
Kupala		37.6	26.2	73.8

Table 2

Protein and amino acid composition of cereals

Varieties	Protein, %		Amino acid content in terms of protein, %	
	Average	Result of research	Essential	Nonessential
Pea				
Ramonsky	18.3	19.5	28.5	71.5
Aist		19.3	32.1	67.9
Malinovka		16.1	33.1	66.9
Barley				
Zhodinsky	13.6	14.3	29.4	70.6
Krynica		13.2	29.6	70.4
Favorit		13.9	29.1	70.9
Yanka		13.1	29.6	70.4
Oat				
Bug	13.7	12.7	28.0	72.0
Los-3		14.3	23.1	76.9
Nemchinovsky		16.6	26.8	73.2
Endskurt		12.4	29.4	70.6
Erbgraf		12.3	32.9	67.1

Table 3

Protein amino acid score of cereal and grain legume crops varieties, %

Varieties	Valine	Isoleucine	Leucine	Lysine	Threonine	Tryptophan	Methionine + cysteine	Phenylalanine + tyrosine
Yellow lupine								
Academichesky	7.4	8.8	11.4	9.1	9.5	17.0	1.2	14.7
BSHA-382	6.6	8.3	11.1	8.0	9.3	–	2.3	12.7
Bistorastuschy 4	6.6	7.8	10.0	9.5	8.5	–	2.3	15.8
Kastrychnik	9.6	10.0	9.3	8.2	8.0	14.0	1.4	12.2
Narochansky	9.2	11.0	12.3	11.3	10.8	16.0	1.2	16.5
Blue lupine								
Nemchinovsky	5.2	8.8	10.3	9.1	9.5	9.0	2.6	13.5
Frost	6.2	8.8	8.1	10.4	9.0	8.0	2.3	13.2
Danko	7.6	9.8	10.7	9.3	9.0	4.0	1.1	12.0
Kupala	7.2	9.8	10.4	8.4	8.8	2.0	0.6	11.0
Pea								
Ramonsky	5.8	7.5	9.6	13.1	8.0	10.0	1.7	12.5
Aist	9.2	8.3	10.0	13.1	10.5	9.0	1.7	12.3
Malinovka	8.4	9.3	11.0	13.1	10.8	10.0	0.6	13.2
Barley								
Zhodinsky	8.8	8.8	9.7	6.2	7.0	11.0	6.6	13.2
Krynica	9.0	8.0	9.7	6.0	7.8	11.0	6.3	12.7
Favorit	8.8	8.5	9.7	6.2	6.5	11.0	6.3	12.8
Yanka	9.2	8.3	9.7	6.0	7.5	11.0	6.3	12.8
Oat								
Bug	9.4	8.3	5.3	11.5	7.5	17.0	2.9	11.7
Los-3	7.8	7.0	7.9	7.1	6.3	–	2.6	9.8
Nemchinovsky	9.0	7.8	8.7	9.5	6.8	–	3.4	11.0
Endskurt	9.6	8.8	9.3	7.8	8.0	14.0	3.4	13.0
Erbgraf	9.8	10.5	9.9	8.7	10.0	14.0	3.4	16.3

High protein content was found in the seeds of oats Nemchinovsky and barley Zhodinsky varieties (Table 2). The content of essential amino acids in these oat varieties ranged from 23.1 to 32.9%, and barley seed was at 29.5% of the protein amino acids. The number of nonessential amino acids of oats seeds was 67.1–76.9%, and barley 70.4–70.9% of all amino acids.

Protein amino acid score of cereals and grain legume varieties is shown in table 3. As can be seen from the data, the biological value of the yellow lupine protein, barley and oats was caused by the presence of the amino acid tryptophan; pea – lysine; blue lupine – leucine and lysine. Methionine was the limiting amino acid score for all the varieties of cereals and grain legumes, the content of which was 0.5–2.3%.

The highest biological value of protein is established in yellow lupine Narochansky; blue lupine Nemchinovsky and Danko; pea Malinovka; barley Zhodinsky; oat Erbgraf varieties.

Conclusion. Our experimental studies have established that the content of essential amino acids in grain legumes (yellow lupine, blue lupine, pea) was 26.2–35.5% from all proteinogenic amino acids, for cereals (barley and oats) – 23.1–32.9%. The rate of nonessential amino acids was determined as 64.5–73.8% in all the amino acids in grain legumes, and 67.1–76.9% for cereals. Methionine was the limiting amino acid for all the studied varieties of plants. The biological value of protein is predetermined by the presence of tryptophan, leucine and lysine amino acids.

Thus, the best varieties among the studied ones were Kastrychnik and Narochansky for yellow lupine; Nemchinovsky for blue lupine; Zhodinsky for spring barley; Nemchinovsky and Erbgraf for oats, judging by quantity and protein composition. These results allow us to recommend these varieties for use as animal feed and a feedstock in production of industrial products on the territory of the Republic of Belarus and abroad.

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