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PROTEINACEOUS FOOD CONCENTRATES FROM GREEN MASS OF PLANTS

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Abstract

Widening the production of food protein and formation of its structure are the most important and difficult tasks for common and healthy nutrition. Constantly deepening deficit of food protein is conditioning the searches for its new sources, including those non-traditional. According to the experts, the productivity of animal origin protein has practically reached its biological limits, and searching for other sources of protein would be possible among the plants.

Therefore, the objectives of this article are to prove scientifically and to confirm experimentally the expedience of using the green mass of various plants.

The subjects for researching are the overground parts of beets, carrot, spinach, purslane, ramsons, nettle etc. collected in summertime. The object is the amino acid content and biological value of green mass of plants, fractional composition of proteins, and the methods to process the green mass into proteinaceous concentrates.

Introduction

The attempts to obtain proteinaceous concentrates out of green mass of plants were accomplished simultaneously in the former Soviet Union and England in 1942. The first publication about leaf protein appeared in 1773 although the term ‘protein’ itself had been firstly proposed by Dutch chemist I. Mulder in 1838 (Peerey, 1980).

Nowadays, there are studied only a few sorts of cultivated plants suitable for obtaining proteinaceous concentrates. These are legumes, alfalfa, rice, rape, clover, green peas. The prominent industrially developed countries have established the powerful agro industrial enterprises dealing with production of food proteins from plant raw materials (dried wheat gluten, high-concentrated forms of protein from soy, wheat and peas) at the end of the 20th century (Kudryashova, 2000). Today the total annual volume of high-concentrated protein production makes up circa 400…500 thousands of tons.

Involving traditional and novelty plant cultures into the sphere of production of protein and protein concentrates would provide solving of an array of social and economical problems, including:

- significant liquidation of food protein deficit, which would foresee both gaining its level in diets and improvement of protein quality;
- organization of industrial production of foodstuffs with definite protein composition, first of all those related to category of healthy food;
- production of high-quality, safe and effective foodstuffs on the base of optimal combination of proteins of both plant and animal origin, which would condition the proper nutritional value and its functional properties (Nechayev, 2001).

The following factors condition the choice of the new raw sources of protein:

- the quantitative and qualitative composition of protein complex;
- functional properties of proteins;
- biological value of proteins;
- the possible volumes of raw harvesting and laying-in (in separate regions and throughout the country);

- technological capacity of raw and its liability to procession on enterprises with different levels of productivity;
- the possibility to obtain several valuable half products with various functional action out of one certain kind of raw;
- maximal compatibility of components from proteinaceous green mass with nutrients of food environments exposed to enrichment;
- shelf-life conditions;
- the cost of proteinaceous half products, regarding their biological value and economic efficiency of an enterprise.

The majority of researches in the field of protein technologies is oriented at obtaining of either high-concentrated proteins (concentrates, isolates, proteinates) or chemically modified, including the composites *protein-polysaccharide*, *protein-lipid* etc.

As for the authors of this article, the more expedient method is the wasteless procession of plant raw materials with further obtaining of proteinaceous concentrates. Those may differ by their rich nutrient composition, first of all – by the optimal natural correlation between proteins and other components of raw (pectin substances and other polysaccharides, lipids and vitamins); thanks to this, the efficiency and functionality of proteins will be enhanced. This technology would become more efficient from economic point of view as well, because it can eliminate the expensive and complicated processes of proteins' purification (in production of concentrates and isolates), their etherification and structuring.

Method

The authors of this article used the standard physical and chemical methods of estimating the plant raw (Yermakov et al., 1987).

- The amino acid composition in green mass of plants was defined by ion-changing chromatography (Spackman, 1988). The essence of this method is to hydrolyze proteins from the sample to amino acids and then to identify them by the method of high-effective liquid chromatography on the LC-5 device (produced by Shimazu). The dry sample had been hydrolyzed with a 6-n solution of hydrochloric acid in the temperature of (108 ± 2) Celsius degrees during 24 hours.

Results and Discussions

The green mass of noticed plants was previously cleaned and inspected. Afterwards, it was disintegrated and its general chemical content was investigated. The obtained results are shown in Table 1.

Table 1

Chemical composition of green mass of proteinaceous plants

Indicators	The raw material						
	Sugar beet	Red beet	Forage beet	Carrots	Ramsons	Nettle	Purslane
Dry substances, %	13.26	12.87	12.51	13.06	10.90	11.86	6.04
Protein, %	3.25	2.64	2.71	2.84	2.18	2.61	1.53
Lipid, %	0.67	0.70	0.41	0.52	0.02	0.49	0.34
Carbohydrates, %	6.22	5.65	5.04	5.70	5.97	5.72	3.38
Ashes, %	2.23	1.88	1.77	1.82	1.35	1.41	0.79

The analysis of the obtained data shows the following facts.

The amount of protein in dry substances allowed arranging the researched objects in the following order: purslane (25.3 %), sugar beet (24.5 %), dioecious nettle (22.0 %), carrots and forage beet (21.7 %), red beet (20.5 %), ramsons (20.0 %).

Our researches have shown that all of the studied objects contain the significant amount of carbohydrates. This indicator is about 55 % of general amount of dry substances in purslane and ramsons; 48.2 % in nettle; 47 % in sugar beet; 44 % in red beet; 43.6 % in carrots; and about 40 % in forage beet.

Purslane is the richest in lipids (5.63 % of general amount of dry substances); the poorest one is ramsons leaves (0.18 %).

Dependently on the amount of ashes in dry substance, the researched objects have been arranged the following: sugar beet (16.8 %), red beet (14.6 %), forage beet (14.1 %), carrots (ca 14 %), ramsons (12.4 %), and nettle (ca 12 %).

Table 2 shows the amino acid content of overground parts of raw plants.

Table 2

The content of indispensable amino acids in overground parts of raw plants

Amino acids	The amount, mg / 100 g						
	Sugar beet	Red beet	Forage beet	Carrots	Ramsons	Nettle	Purslane
Isoleucine	125	113	99	71	143	110	38
Leucine	283	280	269	200	87	155	97
Lysine	205	194	188	155	98	145	72
Phenylalanine + tyrosine	290	225	221	179	135	178	108
Methionine + cystein	113	105	98	73	76	84	20
Tryptophan	42	39	40	32	38	41	45
Threonine	151	127	125	112	92	125	49
Valine	166	153	150	110	93	133	75
Total	1375	1236	1190	932	762	971	504

Table 3 contains the results of researching the dispensable amino acid content in overground parts of raw plants.

Table 3

The content of dispensable amino acids in overground parts of raw plants

Amino acids	The amount, mg / 100 g						
	Sugar beet	Red beet	Forage beet	Carrots	Ramsons	Nettle	Purslane
Alanine	251	187	236	193	87	115	111
Arginine	172	197	185	132	207	235	77
Aspartic acid	250	243	264	210	148	90	117
Hystidine	78	75	67	55	135	123	51
Glutamic acid	248	198	221	139	141	411	71
Glycine	377	334	325	345	183	83	56
Proline	220	199	138	99	104	80	87
Serine	171	146	124	112	107	65	73
Total	1342	2815	2750	2217	2023	2173	1178

Both tables represent the amino acid composition of overground part of plant raw materials. The data show that the entire researched raw contains 18 amino acids including all of those indispensable. It is to mark that the content of indispensable amino acids relatively to the general amino acid amount is about 38…45 per cent, which evidences the significantly balanced amino acid composition in all of the studied objects.

The obtained data show the biological value of proteins in researched green mass of plants. It is well-known that the correlations between dispensable and indispensable amino acids play the crucial role in formation of optimal conditions for catabolic processes. There was experimentally confirmed that the maximal biological effect of food proteins may be reached with the general nitrogen amount of 42 % of indispensable; the other 58 % may be taken from the dispensable amino acids.

In enriching the diets with amino acids, it is necessary to represent them in optimal correlations. Either deficit or surplus of a certain amino acid may cause the misbalance, or a violation of amino acid balance. The symptoms of misbalance can be exposed more apparently in low-protein diet with a small amount of indispensable amino acids.

The data about the biochemical composition of separate plant samples show their wide possibilities in use for human nutrition and production of new foodstuffs. Generally, the plant raw materials chosen as the objects for researches are outstanding due to comparatively high content of protein (20…25 per cent of the whole amount of dry substances).

Moreover, the nutritional value of protein extracted from the studied plants is pretty high and stands close to animal origin proteins. During the researches, we had found out that the proteins of green mass of various beets have got the highest biological value. Henceforth, we may make a conclusion that the proteins from green mass of plants, as being digested in an alimentary canal, would be dissociated by proteolythic enzymes to amino acids and then absorbed into blood wholly.

The further researches foresee the production of dry proteinaceous half-products with wide array of extremely precious biologically active substances. They are chlorophyll and the products of its dissociation; ascorbic acid; carotenoid group, first of all β-carotene. These products would become the most important for the population strata who take the small doses of green leaf vegetables and suffer from the vitamin A deficit.

Therefore, the experimental data obtained during our research show that green mass of plants is a very rich source of a complex of biologically active substances, which would allow obtaining the new foodstuff with increased biological value. Taking green mass for a base to create the biologically active additives and polyfunctional ingredients is grounded scientifically, expedient technologically, and profitable economically; henceforth, the expected products from green mass of plants would have a great demand on both domestic and foreign markets.

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