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RESEARCH ARTICLE

Biochemical tuber composition of promising potato hybrids

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Abstract

The consumption of potato as a food product in Ukraine is currently the main type of use. The Potato Research Institute of Sumy National Agrarian University implements a breeding program for the creation of new nematode-resistant intensive varieties with increased energy value. During 2016-2018, the biochemical composition of tubers of 21 hybrids, including 6 early-maturing, 12 middle-early, 3 middle-maturing, was studied using an infrared analyzer. Increased starch content (84%-80% per dry weight) was observed in 10%, high (73%-72%)-in 14% of the hybrids. Protein content in the tubers was at the level of 6.4% per dry weight, early-maturing hybrids turned out to be the most valuable ones (8.9-8.6%). The high content of vitamin C (89-86 mg%) was accumulated by the middle-early and middle-maturing hybrids, vitamin K (0.26-0.19 mg%)-by the early-maturing hybrids. 28% of hybrids with the maximum (2.2 mg%) potassium content were selected. The amount of nitrate in tubers of 48% of the hybrids did not exceed the maximum permissible concentration. The hybrids with increased and high starch content had a high caloric value ranging from 58 to 55 calorie/100 g. The selection of high-calorie hybrids will enable us to increase the competitiveness of future potato varieties of Sumy NAU breeding in the modern food market.

Keywords: breeding, biochemical composition, caloric value

Introduction

According to Faostat, the current global potato production is 390 million tons, 25% of which is produced by China, 12%-by India, 9%-by Russia, 6%-by Ukraine. In Ukraine, with almost stable potato production at the level of 22 million tons and a consumption fund of 6 million tons, per capita consumption in 2013 was 135 kg, in 2014-141 kg, and in 2018-143 kg. The modern world science confirms the key role of potatoes in ensuring global food security in the future (Duroy 2018; Yang 2016). In January 2015, the Chinese government announced (Gain Report Number: CH15036) efforts to increase potato production to 98 million tons and turn the crop into the country's fourth-largest "grain" after rice, wheat and maize. The energy material of potatoes is starch. The average calorie content of a 100 g food serving of potatoes is between 50 and 85 calories, the maximum is 93 calories and contains essential nutrients such as potassium-18% of the daily requirement, vitamin C-45% of the requirement and dietary fiber-8% (Sastry 2018; Nige 2012). The main factors, affecting the physicochemical, rheological and structural properties of starch suitable for food use, have been determined (Rusia 2012; Ahmadi-Abhari 2013). In terms of starch digestibility, its non-hydrolyzed fibrous fraction (PS) is the most useful as a fermentation substrate for probiotic bacteria. In the raw state, potato starch has 75% of this fraction, when cooking it is reduced by 5%-10%. Despite the obvious positive effects on human health at a rate of 20 g per day, daily PS consumption in Europe, India, New Zealand, Austria, and the United States ranges from 2 to 10 g, in China-18 g, and in developing countries, it can reach 40 g (Dupuis, Liu 2019). The importance of the nutritional value of potatoes is in large amounts of carotenoids in yellow-fleshed tubers (Sulli 2017), with different coloring-vitamins C, B6, and B9. Potatoes are well known as a source of potassium (Duroy, Brown 2019).

The Potato Research Institute of the North-Eastern region of Ukraine as part of Sumy NAU creates new nematode-resistant intensive varieties of potatoes with increased and high nutritional value and at the same time suitable for industrial processing. The creation of new generation potato hybrids has determined the direction of modern research (Grudzińska 2016; Cátia 2019).

The goal of the research is to assess the biochemical composition of potato hybrid tubers. The objectives of the research are to identify the most promising hybrids in terms of energy and nutritional value.

Materials and Methods

Potato hybrids originating from 19 hybrid combinations and two from self-pollination with the involvement of nematode-resistant forms of Belarusian (63%), the Ukrainian (23%) and foreign (15%) breeding were used as the parent material. 21 hybrids, including 28.6% of early-maturing, 57.1% of middle-early and 14.3% of middle-maturing forms, were studied.

The hybrids had high rates of economic viability. At the average value of commercial yield at the level of 40.5 t/ha, the variation was 58-33 t/ha. 10% of hybrids (205.791-3, 205.792-205, 203.703-3, 99.523-7) were characterized by the yield of 58-44 t, 33%-43-40 t/ha and 57% of hybrids-39-33 t/ha. The dry matter content of commercial tubers of early-maturing hybrids was 17.9%, middle-early-23.1% and middle-maturing-28.4%, standard-25, and 28.6%. The components of the biochemical composition of commercial tubers were studied using an infrared analyzer; the caloric value of hybrids was calculated based on the output of the number of calories from 100 g of the product by the express method of Honcharov M. D.

The study was carried out during 2016-2018 with the cultivation of parent material in the scheme of the breeding process in the experimental field of the educational and scientific production complex of Sumy NAU with the use of drip irrigation. Different weather conditions of the potato growing season according to the Institute of Agriculture of the North-East of NAAS (2016-water logging, 2017-sufficient moisture, 2018-drought) led to an objective assessment of the study results.

Results and Discussion

The biochemical composition of tubers is one of the most important indicators of the nutritional value of potatoes (Tab. 1).

Any food should correspond to physiological saturation and be tasty. The elements of the physiological usefulness of food have the following groups: energy sources (carbohydrates), proteins, vitamins, and minerals. Therefore, the nutritional assessment of potato hybrids is differentiated by these main groups of elements.

Thus, starch with its average content in the tubers of hybrids amounting to 64% per dry weight, the minimum content was 45, the maximum-84%. An increased starch content (84%-80%) was observed in 10%, high (73%-72%)-in 14% of hybrids. According to the indicator value, the middle-maturing hybrids are the most valuable ones (205.786-72, 205.798-45), the middle-early (99.523-7, 205.780-8) and middle-maturing hybrids (205.782-24) are valuable. In general, the starch content of tubers grew from early-maturing (49.8%) and middle-early (63.7%) to middle-maturing forms (79%). Reducing sugars were accumulated in a greater degree by early-maturing hybrids (0.22%), in a lesser degree-by the middle-early (0.14%) and middle-maturing (0.09%) hybrids. Almost in all of the studied samples, except for 205.785-25, the level of reducing sugars do not exceed the optimal value that is very important when using raw potatoes.

Crude protein content averaged 9.6% with a range of 7.20 to 13.39%. It has been revealed that the level of the indicator depends on the biological characteristics of the studied hybrids. The early-maturing hybrids are characterized by a high content of crude protein-11.1%, tubers of the middle-early forms-9.27%, and middle-maturing-only 7.83%. Along with the high content of crude protein in the early-maturing hybrids, some middle-early forms by this indicator reach almost the same level-205.783-13 (10.72%), 203.703-3 (10.57%), 205.780-89 (10.41%).

It is well known that on average, raw potato protein is 60% protein. According to the results obtained, this indicator in the tubers of the studied hybrids is 66.6%, of which the early-maturing and middle-early hybrids are characterized by the indicator amounting to 68.8%, and middle-maturing-60.5%. The studied hybrids differ in the quantitative content and qualitative composition of proteins (Tab. 2).

The average protein content is 6.4% per dry weight with growth from the middle-maturing (4.74%) to middle-early (6.37%) and early-maturing (8.06%) forms. According to the quantitative protein content, the most valuable (8.97%-8.58%) have turned out to be the early-

Table 1. Features of the biochemical composition of potato hybrid tubers, the average for 2016-2018.

Breeding number	Starch,% per raw weight	Content,% per dry weight					The ratio of starch to protein
		Starch	reducing sugars	crude protein	Protein	Lipids	
			Early-maturing				
203.703-2	14.2	57.9	0.22	12.39	8.58	1.12	6.7
205.792-205	11.9	50.9	0.18	11.57	7.44	1.16	6.9
99.517-39	11.9	50.9	0.20	10.88	8.97	0.91	5.7
205.785-25	11.0	47.9	0.30	12.01	7.36	1.14	6.5
99.523-15	10.7	47.0	0.29	11.50	7.22	1.16	6.5
205.791-3	10.0	44.8	0.19	11.93	8.80	0.82	5.1
Average	11.6	49.8	0.22	11.71	8.06	1.05	6.2
			Middle-early				
99.523-7	18.7	71.8	0.03	8.14	5.61	1.30	12.8
205.780-8	18.7	71.8	0.21	10.41	6.21	1.06	10.6
205.776-26	17.7	68.7	0.17	8.18	4.91	0.91	13.7
203.703-3	17.5	68.2	0.24	10.57	7.15	1.40	9.5
98.488-17	15.9	63.7	0.03	8.58	5.92	1.13	10.8
205.770-13	15.4	61.8	0.06	9.00	6.71	1.25	9.2
205.783-13	15.4	61.8	0.25	10.72	6.99	0.88	8.8
99.545-4	14.7	59.5	0.12	9.20	5.42	0.99	9.3
204.723-8	14.7	59.5	0.23	8.95	6.24	0.97	9.6
205.781-9	14.7	59.5	0.11	9.20	7.16	1.33	8.3
99.546-3	14.4	58.7	0.17	9.44	6.32	0.99	9.3
205.788-3	14.4	58.7	0.07	8.79	6.83	1.48	10.6
Average	16.0	63.7	0.14	0.14	6.37	1.14	10.1
			Middle-maturing				
205.798-45	23.0	84.3	0.04	7.67	4.38	1.24	19.1
205.786-72	21.7	80.4	0.09	8.63	4.99	0.99	18.7
205.782-24	19.0	72.6	0.15	7.20	5.56	0.87	13.2
Average	21.2	79.0	0.09	7.83	4.74	1.03	16.7

Table 2. The qualitative composition of proteins of potato hybrids, the average for 2016-2018.

Maturity group	Aminoacids, % per dry weight			The ratio of dispensable and indispensable amino acids	Content of indispensable amino acids,%
	Amount	Indispensable	dispensable		
Early-maturing	5.13	3.25	1.88	1.73	40.8
Middle-early	3.67	2.29	1.70	1.62	36.7
Middle-maturing	3.86	2.46	1.40	1.75	50.0

maturing hybrids 99.517-39, 203.703-2, 205.791-3. The composition of valuable hybrids in terms of the protein content of more than 7% should include the three early-maturing forms-205.792-205, 205.785-25 and 99.523-15 and the two middle-early ones, namely-205.781-9 and 203.703-3.

The analysis of the expression of such indicator as the ratio of starch to protein has revealed its clear increase by the group of hybrid maturity from early-maturing (6.2) to middle-early (10.1) and middle-maturing (16.7). The middle-maturing hybrids 205.786-72 and 205.798-45 are characterized by the greater amount of indispensable amino acids as part of the protein (59-53%), then the middle-early hybrids 205.780-8 and 205.783-13 (50%-48%) and the early-maturing hybrids 99.523-15, 203.703-2, 205.785-25(49%-48%). Proteins of middle-maturing hybrids are 50% composed of indispensable amino acids, early-maturing-40.8%, middle-maturing-36.7%. The early-maturing 205.785-25, 99.523-15 and the middle-early 205.783-13 hybrids were characterized by the greater ratio (2.2-2.1) of indispensable to dispensable amino acids; the ratio 2.0-1.8 is observed in 28.6% of the hybrids of different maturity forms: 99.523-7, 205.786-72, 205.770-13, 205.776-26, 205.780-8, 203.703-2 have the ratio of 2.0-1.8; 38% hybrids 205.798-45, 205.782-24, 205.788-3, 205.792-205, 203.703-3, 205.791-3 are characterized by the ratio of 1.7-1.5 and 19%.

Fewer hybrids have the ratio of dispensable and indispensable amino acids amounting to 1.4-1.2. These hybrids include the middle-early hybrids 98.488-17, 99.546-3, 204.723-8 and the early-maturing one-99.517-39. The data are given in Tab. 3 indicate the qualitative composition of indispensable amino acids of potato hybrids.

Lysine is of particular importance, and its daily need of the human body is 5.2 grams. By the average lysine content of 0.12%, the early-maturing hybrids are characterized by a higher content, the most valuable of these hybrids are the hybrid 205.703-2 (0.46%), then 205.785-25 (0.27%),

Table 3. Content of indispensable amino acids in potato hybrid tubers, the average for 2016-2018.

Breeding number	Content, % per dry weight										
	Valine	Leucine	Isoleucine	Threonine	lysine	phenylalanine	tyrosine	Arginine	histidine	glutamine	methionine
					Early-maturing						
203.703-2	0.40	0.38	0.19	0.29	0.46	0.25	0.27	0.63	0.14	1.01	0.09
99.523-15	0.32	0.27	0.14	0.15	0.25	0.20	0.40	0.66	0.16	0.96	0.05
205.785-25	0.35	0.24	0.12	0.17	0.27	0.18	0.23	0.60	0.14	1.21	0.05
205.791-3	0.37	0.26	0.13	0.21	0.24	0.17	0.40	0.61	0.11	0.30	0.06
99.517-39	0.34	0.21	0.18	0.22	0.19	0.14	0.32	0.34	0.09	0.69	0.07
205.792-205	0.35	0.16	0.10	0.15	0.10	0.17	0.36	0.63	0.06	0.54	0.04
Average	0.36	0.25	0.14	0.17	0.23	0.17	0.32	0.57	0.10	0.78	0.05
					Middle-early						
205.783-13	0.29	0.29	0.12	0.19	0.25	0.17	0.29	0.58	0.12	1.01	0.06
205.780-8	0.27	0.30	0.12	0.23	0.18	0.14	0.38	0.43	0.10	0.92	0.07
205.788-3	0.21	0.20	0.11	0.14	0.04	0.08	0.31	0.47	0.08	0.81	0.04
99.523-7	0.21	0.20	0.12	0.16	0.04	0.08	0.40	0.39	0.08	0.70	0.05
203.703-3	0.21	0.09	0.08	0.09	0.01	0.03	0.47	0.23	0.06	0.92	0.02
205.776-26	0.14	0.16	0.07	0.08	0.01	0.04	0.38	0.40	0.08	0.83	0.02
205.770-13	0.17	0.09	0.05	0.01	0.04	0.03	0.39	0.32	0.06	1.00	0.02
204.723-8	0.27	0.18	0.14	0.18	0.04	0.07	0.23	0.33	0.07	0.47	0.05
99.546-3	0.22	0.11	0.09	0.12	0.02	0.03	0.23	0.29	0.06	0.76	0.03
99.545-4	0.20	0.14	0.06	0.08	0.01	0.06	0.22	0.43	0.09	0.51	0.02
205.781-9	0.21	0.13	0.07	0.07	0.02	0.05	0.25	0.43	0.08	0.50	0.02
98.488-17	0.21	0.11	0.08	0.15	0.02	0.06	0.23	0.39	0.08	0.44	0.05
Average	0.22	0.17	0.09	0.12	0.05	0.07	0.31	0.38	0.08	0.75	0.04
					Middle-maturing						
205.786-72	0.21	0.27	0.12	0.19	0.11	0.11	0.46	0.43	0.10	0.91	0.06
205.798-45	0.16	0.22	0.10	0.17	0.04	0.06	0.47	0.31	0.06	0.67	0.05
205.782-24	0.11	0.16	0.08	0.07	0.06	0.04	0.41	0.12	0.04	0.99	0.02
Average	0.16	0.21	0.10	0.14	0.07	0.08	0.45	0.29	0.07	0.85	0.04

99.523-15 (0.25%), 205.791-3 (0.24%) and the middle-early hybrid 205.783-13 (0.25%).

Among all indispensable amino acids in tubers of the hybrids studied, glutamine is characterized by the highest content-0.79%, which is 6.6 times more than lysine. The early-maturing and middle-maturing forms have almost the same value of glutamine content, respectively 0.78 and 0.75%, tubers of middle-maturing forms contain 0.85%. Of these, the hybrids 205.782-24 and 205.786-72 accumulate 0.99-0.91% of this amino acid. The early-maturing hybrids 205.785-25 and 203.703-2 and middle-early hybrids 205.783-13, 205.770-13, 205.780-8, 203.703-3, with the higher content of glutamine amounting to 1.21-0.92%, are identified.

The hybrids have the lower content of amino acids such as arginine (0.41%), tyrosine (0.36%), valine (0.25%) and leucine (0.21%). The amount of arginine and valine has increased from middle-maturing to early-maturing forms, leucine vice-versa. The content of leucine in early-maturing and middle-maturing hybrids turned out to be greater than in the middle-early hybrids.

The amino acid such as threonine by average content (0.14%) is almost equal to the content of lysine. The content of such indispensable amino acids as isoleucine, phenylalanine, histidine, and methionine decreases from 0.11 to 0.04%. The early maturing forms are characterized by a larger number of these amino acids. Vitamins and mineral elements belong to the third group of elements of physiological full value. The data on the amount of these substances depending on the group of maturity of the samples (Tab. 4).

With an average value of vitamin C in the tubers of the studied hybrids amounting to 82 mg%, the higher content is accumulated by the middle-early and middle-maturing (84 mg%) forms against the early-maturing one (78 mg%). The high content of vitamin C (89-86 mg%) is observed in such middle-early hybrids as 205.776-26, 205.781-9, 205.770-13, 99.545-4 and middle-maturing 205.782-24. In other hybrids of these maturity groups and in the early-maturing hybrid 205.785-25, the content of vitamin C ranges from 85 to 80 mg%.

The early-maturing forms have a high content of carotenoids (0.26 mg%), which is 3 and 6 times higher than this figure in the middle-early and middle-maturing ones (0.07 and 0.03 mg%). Thus, the content of vitamin C grows from early-maturing to middle-maturing forms, vitamin K, on the contrary, decreases.

Among food products, potatoes are the main source of potassium. Daily consumption of 500 g of potatoes provides daily needs. We have distinguished 28.6% of hybrids with the maximum content of this element, the half of which is the middle-early forms 99.545-4, 205.770-

13, 205.776-26, the second half is the middle-maturing forms 205.782-24, 205.786-72, 205.798-15. A greater amount of potassium is accumulated by the middle-maturing (2.07 mg%) and middle-early forms (1.94 mg%) than early-maturing (1.59 mg%).

The amount of magnesium practically does not depend on the maturity group (0.12-0.11-0.10 mg%), the amount of phosphorus and potassium has tended to decrease from the early-maturing (0.23-0.34 mg%) and middle-early (0.20-0.23) to middle-maturing forms (0.19-0.19 mg%). The data are given in Tab. 5.

The early-maturing hybrids with the increased and high content of vitamin K (0.26-0.19 mg%) such as 205.791-3, 203.703-2, 205.792-205, 99.517-39, 99.523-15 and 205.785-25 have been distinguished. These hybrids may be of great preventive value for consumption in areas contaminated with radionuclides.

It has been found that some hybrids with yellow and cream pulp contain carotenoids being 1.2 and 1.6 times more than white. The early-maturing hybrids 205.703-2, 205.791-3 with colored pulp and carotenoid content up to 0.26 mg% is of particular value. But according to the average data, only the trend in the influence of the tuber pulp coloring on the content of vitamins and mineral elements, including potassium has been revealed in the studied hybrids (Tab. 6).

Table 4. Distribution of vitamins and mineral elements by their content in tubers of hybrids of different maturity groups, the average for 2016-2018.

Maturity group	Content, mg% per dry weight						
	Vitamin C	Vitamin K	Mineral elements				
			P	Ca	Mg	K	amount
Early-maturing	78.09	0.22	0.23	0.34	0.12	1.59	2.18
Middle-early	84.39	0.07	0.20	0.23	0.11	1.94	2.48
Middle-maturing	84.73	84.73	0.19	0.19	0.10	2.07	2.55

Table 5. Content of vitamins, mineral elements in tubers of potato hybrids, the average for 2016-2018.

Breeding number	Dry matter,% per wet weight	Content,% per dry weight						
		vitamin C	vitamin K	Mineral elements				
				P	Ca	Mg	K	amount
			Early-maturing					
205.785-25	17.2	80.56	0.19	0.24	0.31	0.13	1.71	2.58
205.792-205	18.3	78.92	0.21	0.22	0.32	0.11	1.53	2.16
99.523-15	16.9	78.92	0.21	0.22	0.32	0.11	1.53	2.18
205.791-3	16.1	77.53	0.26	0.23	0.36	0.12	1.55	2.26
203.703-2	20.8	75.40	0.26	0.25	0.38	0.12	1.57	2.32
99.517-39	18.3	77.20	0.21	0.22	0.34	0.11	1.67	2.34
			Middle-early					
205.776-26	24.7	88.87	0.01	0.19	0.16	0.11	2.14	2.60
205.781-9	21.4	87.43	0.01	0.20	0.20	0.11	1.95	2.46
205.770-13	22.2	86.66	0.01	0.19	0.19	0.10	2.07	2.55
99.545-4	21.4	86.21	0.12	0.20	0.19	0.12	2.00	2.51
205.788-3	21.1	84.92	0.01	0.20	0.20	0.11	1.94	2.45
99.523-7	25.8	84.76	0.04	0.20	0.21	0.10	1.96	2.44
98.488-17	22.9	84.58	0.10	0.19	0.23	0.10	1.91	2.43
203.703-3	24.5	83.80	0.02	0.19	0.23	0.11	1.98	2.57
99.546-3	21.1	83.66	0.07	0.19	0.24	0.10	1.92	2.45
205.783-13	22.2	81.77	0.09	0.23	0.28	0.12	1.81	2.44
204.723-8	21.4	81.77	0.15	0.20	0.27	0.10	1.80	2.37
205.780-8	25.8	78.21	0.17	0.22	0.32	0.11	1.81	2.46
			Middle-maturing					
205.782-24	26.1	87.53	0.01	0.17	0.15	0.10	2.20	2.62
205.786-72	28.9	83.57	0.05	0.20	0.23	0.11	2.00	2.54
205.798-45	30.3	83.09	0.04	0.19	0.21	0.10	2.02	2.52

Table 6. Effect of pulp coloring on the content of vitamins and potassium in potato hybrid tubers, the average for 2016-2018.

Pulp coloring	Number of hybrids		Content, mg% per dry weight			
	pcs	%	vitamin C	Vitamin K	Mineral elements	
					K	amount
White	7	33	83.4	0.08	1.88	2.42
Light yellow	6	29	82.2	0.10	1.88	2.50
Yellow	3	14	81.0	0.10	1.81	2.41
Creamy	5	24	82.2	0.13	1.84	2.42

Table 7. Energy value of the maturity groups of potato hybrids, the average for 2016-2018.

Maturity group	Content, cal/100 g product			Output, thousand kcal/ha		
		± to variety			Output, thousand kcal/ha ± to variety	
	$\bar{x}$	Honcharivska	Smuhlianka	$\bar{x}$	Honcharivska	Smuhlianka
Early-maturing	34.2	-20.9	-14.1	14.9	-1.7	-3.9
Middle-early	44.1	-11.0	-4.2	17.7	+1.1	-1.1
Middle-maturing	54.7	-0.4	+6.4	19.1	+2.5	+0.3
Honcharivska	55.1	0	-	16.6	0	-
Smuhlianka	48.3	-	0	18.8	-	0

One aspect of potato consumption safety is related to the number of nitrates. It is proved that the value of this indicator in tubers of 48% of hybrids does not exceed the maximum permissible concentration of 140 mg/kg. Such forms include the middle-maturing hybrids-205.782-24, 205.786-72, 205.798-45, a greater number of middle-early-205.776-26, 205.781-9, 99.545-4, 99.523-7, 98.488-17 and the early-maturing hybrid 205.785-25. Nitrate content in the early-maturing hybrids 99.517-39, 205.792-205, 205.791-3 has reached 190-185 mg/kg, in the middle-early forms 205.783-13, 205.780-8-170 mg/kg.

The caloric value of potato hybrids taking into account the generally accepted statement that the main energy material of potatoes almost exclusively (96%) is starch and its actual level in the studied hybrids, it is found out that the average calorie content of 100 grams of fresh potato of hybrids is 44 calories, the minimum-30, the maximum-58. The middle-maturing hybrids 205.792-45, 205.786-72, 205.782-24 with increased (23-21.7%) and middle-early-99.523-7, 205.780-83 with high (19%) starch content are characterized by higher caloric value. Deviations from the maximum value of caloric content of the selected valuable forms and from this indicator of standard varieties are established for other hybrids in terms of maturity groups. In addition, from the point of view of the production of potato hybrids as a food product, with the actual commodity yield, the average potential level of their energy value per area unit can reach up to 19 thousand kcal 22 (Tab. 7).

The data on the energy value of the maturity groups of hybrids and varieties implies the following. The caloric value of the middle-maturing forms is 1.2-1.6 times higher than that of the middle-early and early-maturing ones.

Compared with the energy value of the varieties of Honcharivska (55 cal/100 g) and Smuhlianka (48 cal), the middle-maturing hybrids relative to the Smuhlianka variety had the advantage of 6.4 cal/100 g of the product. With regard to the energy value of a separate group of maturity hybrids per area unit, the middle-maturing and middle-early forms dominated the Honcharivska variety by 2.5 and 1.1 thousand kcal. The same value of the middle-maturing hybrids (19.1 thousand kcal) and the Smuhlianka variety (18.8 thousand kcal/ha) was found.

Discussion

Historically, breeding has focused more on yield than quality. The modern realistic approach to potato breeding is to create highly productive intensive varieties with quality indicators, systematized towards product use. The new Sumy potato varieties and hybrids were created to solve the problem of potato globoderosis in the North-Eastern region of Ukraine (Abu Obaid 2017). 43% of forms with increased (58-44 t/ha) and high (43-40 t/ha) commercial yield, 24%-with increased (23-22%) and high (19%) starch content, protein content (9-8% per dry weight)-14%, vitamin content (89-86 mg% of vitamin C and 0.26-0.19 mg% of vitamin K) and high potassium content (2-2, 2 mg%)-28%, 48% forms with nitrate content less than the maximum permissible concentration, were selected among the new potato hybrids. 57% of hybrids were distinguished according to the possibility of increasing potatoes as a food product per area unit and high consumer quality (Kalita 2017; Gibson 2013).

To compare the assessment of economic viability and biochemical composition of tubers of Sumy potato hybrids, the following study results as of 2018 regarding Belarusian, Ukrainian and other breeding, the varieties and hybrids of which were used as parent forms. The Belarusian breeders (Honcharova N. N.) created inbred potato lines with high stable productivity (more than 1200 g/h up to the 6th generation inclusive), with starch content above 18%, reducing sugars below 0.20% after storage. The systematization of the varieties of Belarusian and Russian hybrids (Chalaia N. A., Rohozin E. V.) breeding for their table use and possible implementation in the trade network was carried out (Abu Obaid 2018).

A new direction of potato breeding has been opened to improve the nutritional value, namely, the creation of varieties with colored pulp and peel, which have a high antioxidant capacity. The Ukrainian (Furdyha M. M.) and Belarusian (Kozlov V. A., Kozlova L. N., Piskun H. I.) scientists proved in 2010-2018 that tubers with purple and red pulp have the antioxidant capacity, which is 2.7 times higher than that of the samples with cream, yellow and white pulp. In tubers with purple peel, this ability is

1.6 times higher than in tubers with red pulp and 3.3 times higher than in tubers with yellow peel. In this regard, the Sumy potato hybrids with purple peel (205.776-26, 205.785-25), which contain respectively 89 and 0.19 mg% of vitamins C and K per dry weight, are of particular value (Glaz 2018). The hybrids with dark pink peel (205.788-3, 205.798-45) accumulated-85-83 mg% of vitamin C, with light pink peel (205.791-3, 205.792-205)-0.26-0.21 mg% vitamin K. It is found that the hybrids with yellow and cream pulp contain more carotenoids (Şerban 2014; Larder 2018).

Conclusion

The biochemical composition and energy value of tubers have been studied in the potato hybrids created and distinguished by the main economically valuable characteristics. The dependence of these indicators on the group of ripeness and genotype has been revealed. 57% of hybrids from their total number have been distinguished by the aggregate energy value, the possibility of increasing the production of potatoes as a food product per unit of acreage. Such hybrids will provide the possibility of competitiveness of future potato varieties of Sumy NAU breeding in the modern food market. Further research is aimed at determining the biochemical nature of culinary quality indicators of the created hybrids.

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