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Protein and Starch Content in the Collection of Barley Samples in the Conditions of the Northern Trans-Urals

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ABSTRACT

The article presents the biochemical characteristics of the collection of chaffy barley samples of Federal State Budgetary Scientific Institution "Federal Research Center the N. I. Vavilov All-Russian Institute of Plant Genetic Resources", grown in the Northern forest-steppe of the Tyumen region in 2011-2013 on the experimental field of the Northern Trans-Urals State Agrarian University. The soil is leached chernozemic soil, low-power, heavy loam. Field experiments have been conducted in accordance with the "Guidelines for the study and preservation of the world's collection of barley and oats". 127 barley samples have been studied, and Acha variety of chaffy barley has been used as a standard. According to the protein content, the samples are classified into five groups. The largest number of samples (38%) belonged to the fourth group, where the protein content was 14.1-15.0%, 29% of samples corresponded to the third group (protein content 13.1-14.0%), and 22% – to the fifth group (protein content 15.1-17.0%). In the first group, where the protein content is 10.1-12.0%, and in the second group, where the protein content is 12.1-13.0%, the number of samples is significantly lower (4 and 7%, respectively). The highest average weight of 1000 grains were observed in barley samples of the fourth group (48.7 g), the fifth (48.6 g) and the first (48.3 g). The samples of the third group value of feature below – 46,3 g, in samples of the second group, where the protein content of 12.1 to 13.0%, the lowest share of 43.7 g. The starch content in the grain samples of barley tended to decrease from the groups with a low percentage of protein groups with middle and high content. The amount of starch in the samples of the first and second groups at the level of 61.6% and 60.7%, then there is a downward trend: from 60.1 to 58.6%. Taking the high value of the protein content in the barley grain for feed purposes into consideration, the table shows the samples with more than 15% protein in the grain. All of them (30 of them) significantly exceed the protein content of Acha barley variety approved for use in the region (an excess of 2.4-4.2%). It should be noted the peculiarity of many samples of this group – the ability to form a large and full-weight grain. Viking (K-30471) from Germany (58.2 g) and Luka (K-30899) from the Kemerovo region (58.1 g) were characterized by the highest 1000 grains weight. Such varieties as I. AHOR 2542/63 from Ethiopia (K-20024), Aria from Sweden (K-20508), Anadolu 86 (K-30319) and Obruk 86 (K-30320) from Turkey, L-5 Krinichniy (K-30439) from Belarus, Karabalyk 5 (K-30774) from the Chelyabinsk region, Pervotselinnik (K-30895) from the Orenburg region, Sokol (K-30827) and Zernogradsky (K-30453) from the Rostov region significantly exceeded the standard for this feature (by 4-7G) . Special attention should be paid to samples of the collection with a complex of high indicators and exceeding the standard for yield. This is a Pervotselinnik from the Orenburg region (K-30895): protein content of 16%, starch-59.1%, weight of 1000 grains-50.3 g, exceeding the standard yield of 10%; Luka from the Kemerovo region (K-30899): protein content of 16.2%, starch – 58.8%, weight of 1000 grains – 58.1 g, exceeding the standard yield of 21%. Thus, the classification of samples of the barley collection by the protein content in the grain allowed us to identify a number of features characteristic of certain groups, and to identify samples with a complex of valuable features.

Key words: Barley, Samples of the collection, Protein content, Starch content, Mass of 1000 grains, Starch/protein ratio

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INTRODUCTION

The main storage compound that determines the nutritional value of cereals are protein and starch. For their formation, plastic substances are most intensively supplied from the vegetative organs of plants to the grains in the grain filling phase [1-5]. Depending on the ratio between the content of nitrogenous substances and

carbohydrates, the indicator of grain protein content of individual genotypes is considered [6-9].

According to previous studies, the protein content in large, medium and small grains of Kutulukskaya wheat variety was 12.0-12.7%, starch in the grains of Kinelskaya 60 wheat variety was 70.2-78.8 %, the protein content was almost at the same level (12.0-13.0%), the starch content in grains of various sizes was lower– 68.7-75.2%.

Grain crops also differ in the accumulation of proteins of individual fractions and their quantitative ratio [10-16].

The influence of meteorological factors on the process of synthesis of grain storage compound is established. It is shown that if the protein content in grain increased under adverse growing conditions (e.g., drought), it is not due to an enhanced synthesis and inhibition of starch deposits [17-20].

In the conditions of the Volga forest-steppe, preceding crops and fertilizers had a positive effect on the protein content in barley grain [21-24]. When barley is grown according to its preceding crop– peas with fertilizers based on a grain yield of 4 t/ha, the protein content in the barley grain reached 14.9%, the amount of starch in the grain was 53.3%. To increase the nutritional value of feed, it is proposed to bare-grained barley, this forms a grain with a higher protein content in comparison with chaffy forms [25-27]. Popolzukhin et al. [28,29] presented the biochemical characteristics of the grain of new chaffy barley varieties grown in the Omsk region. The protein content in the grain of the new varieties of barley Gift of Siberia and Sasha for three years of research was 13.5 and 13.6%, starch content-55.2 and 53.9%, fat content-2.2 and 2.1%, respectively.

The purpose of the research

To give a biochemical characteristic of the grain samples of the barley collection grown in the Northern forest-steppe of the Tyumen region.

MATERIAL AND METHODOLOGY

The research has been carried out on leached, low-power, heavy-loam chernozemic soil in 2011-2013 on the experimental field of the Northern TRANS-Urals State Agrarian University.

The samples of the collection of Federal State Budgetary Scientific Institution "Federal Research Center the N. I. Vavilov All-Russian Institute of Plant Genetic Resources" have been studied in the amount of 127 samples, the standard was adopted for Acha chaffy barley variety. The research has been conducted in accordance with the" Guidelines for the study and preservation of the world collection of barley and oats " [30].

The study of the biochemical composition of grain has been carried out on the basis of the laboratory of biochemistry and molecular biology of Federal State Budgetary Scientific Institution "Federal Research Center the N. I. Vavilov All-Russian Institute of Plant Genetic Resources". The protein and starch content in the grain was evaluated by infrared spectroscopy using the Infratec 1241 Grain Analyzer (Sweden).

For the distribution of samples of barley protein content based on the group's International classification of CMEA of the genus Hordeum L.: 1– ery low (less than 8.1%); 2– very low (8.1-9.0%); 3–low (9.1-10.0%); 4 low (10.1-12.0%); 5 – medium (12.1-13.0%); 6–medium (13.1-14.0%); 7–high (14.1-15.0%); 8 – high (15.1-17.0%); 9–very high (over 17%).

There were no samples with a protein content of up to 10% or more than 17% in the collection, so we accepted the values of groups from 4 to 8, which were given the appropriate numbering: 1, 2, 3, 4, 5 (table 1). Ehere were то samples with a protein content of up to 10% or more than 17% in the collection, so we accepted the values of groups from 4 to 8, which were given the appropriate numbering: 1, 2, 3, 4, 5 (Table 1).

According to the Table 1, the largest number of samples (38%) was in the fourth group, where the protein content was 14.1-15.0%, 29% of samples corresponded to the third group (13.1-14.0%), and 22%–to the fifth (15.1-17.0%). In the first and second groups, the number of samples is significantly lower (4 and 7%).

Table 1: Weight of 1000 grains and the amount of starch in the grain of samples of the barley collection, differing in protein content, 2011-2013.

Group number	Содержание белка. %	Number of samples	Weight of 1000 grains. g		Starch. %	Starch/protein (ratio)		
			Medium	Limits	Medium	Limits	Medium	Limits
1	Low: 10.1-12.0%	5	48.3	41.0-55.0	61.6	60.6-62.8	5.3	5.1-5.7
2	Medium: 12.1-13.0%	9	43.7	37.5-50.7	60.7	55.1-62.0	4.8	4.6-5.0
3	Medium: 13.1-14.0%	37	46.3	35.6-53.4	60.1	58.5-62.1	4.4	4.2-4.7
4	High: 14.1-15.0%	48	48.7	35.1-58.3	59.8	49.5-61.6	4.1	3.3-4.4
5	High: 15.1-17.0%	28	48.6	33.6-59.2	58.6	47.3-60.8	3.8	2.9-4.8

Group numbers (1, 2, 3, 4, 5) correspond to 4, 5, 6, 7, 8 groups of the CMEA classifier [30].

The highest medium weight of 1000 grains was observed in barley samples of the fourth group (48.7 g), the fifth (48.6 g) and the first (48.3 g).

The samples of the third group value of feature below – 46,3 g, and samples of the second group, where the protein content of 12.1 to 13.0%, the lowest share of 43.7 g.

The limits of variation of mass of 1000 grains greater in groups with high protein content. The range of variation of the trait was 14.0 g, 13.2 g, 17.8 g, 23.2 g, 25.6 g, which indicates a significant increase in the groups with a protein content of 13.1 to 17.0%.

The starch content in the samples of the first and second groups at the level of 61.6% and 60.7%, then there is a downward trend: from 60.1 to 58.6%.
The limits of variation in the starch content of barley samples, as well as the mass of 1000 grains, are more significant in groups with a high protein content. In the same groups, the range of variation of the trait is much higher: 12.1% and 13.5%. In the first, second and third groups, this indicator is lower: 2.2%; 6.9%; 3.6%, respectively.

The starch/protein ratio content decreased from 5.3 (the first group) to 3.8 (the fifth group).

The largest amount of variation was observed in the samples of the fifth group (1.9) and the fourth (1.1). In the other groups, this indicator was at the level of 0.4-0.6.

Taking the high value of the protein content in barley grain intended for feed purposes into consideration, it was advisable to present the characteristics of high-protein samples (more than 15% protein) and other characteristics. Table 2 shows the samples of the fifth group, all of them significantly exceed the protein content of Acha barley variety approved for use in the region (an excess of 2.4-4.2%).

Table 2: Characteristics of high-protein barley samples from the VIR collection, 2011-2013.

VIR catalog number	Variety sample	Origin	Protein. %	Starch. %	Weight of 1000 grains. g
30243	Acha. standard	The Novosibirsk region.	12.6	61.8	46.3
24825	The Botanical form	Germany	15	49.5	48.7
30471	Viking	Germany	15	60.1	58.2
30888	Petr	The Kemerovo region	15	60.4	49.6
4697	Mestniy	Armenia	15.1	59	42.3
14925	Mestniy	Tajikistan	15.1	59.6	42.4
28119	Kedr	The Krasnoyarsk region	15.1	60.8	47.5
15519	Mestniy	Kazakhstan	15.2	58.8	42.5
20213	Mutant 2207	Germany	15.2	60.8	46.3
30461	Viivi	Finland	15.2	59.2	49.9
30882	Stimul	The Krasnodar region	15.2	60.4	47.2
30890	Bakhus	The Krasnoyarsk region	15.2	60.6	47.1
30439	L-5 Krinichniy	Belorussia	15.5	59.4	52.9
24884	The Botanical form	Czech Republic	15.5	59.7	47.5
30918	Omskiy 91	The Omsk region	15.6	60.1	49
30774	Karabalyk 5	The Chelyabinsk region	15.6	60	50.8
20024	I.AHOR 2542/63	Ethiopia	15.7	50	52.9
20508	Aria	Sweden	15.7	59.5	51.3
19709	Mestniy	Denmark	15.8	58.5	43.6
30663	C. I. 11073	Peru	15.8	58.9	33.6
30436	Nutans 2419	The Samara region	15.9	58.6	47.5
30895	Pervotselinnik	The Orenburg region	16	59.1	50.3
30829	Anna	The Orenburg region	16.1	59.1	49.3
30320	Obruk86	Turkey	16.2	58.9	53.3
30899	Luka	The Kemerovo region	16.2	58.8	58.1

30827	Sokol	The Rostov region	16.3	59.2	52
30892	Naran	The Buryat region	16.3	59.4	50.3
30319	Anadolu86	Turkey	16.5	58.4	52.9
30453	Zernogradsky	The Rostov region	16.6	59.5	50.3
30748	L-1899	The Kemerovo region	16.6	47.3	48
30894	Adamovskiy 1	Buryat region	16.8	58.2	49.4
HCP 05			0.4	0.6	1.6

A number of these samples had a high starch content (60.6-60.8%) and were worse in this indicator than Kedr and Bakhus from the Krasnoyarsk region, Mutant 2207 from Germany.

It should be noted that many samples of this group can form large and full-weight grains. Viking (K-30471) from Germany (58.2 g) and Luka (K-30899) from the Kemerovo region (58.1 g) were characterized by the highest weight of 1000 grains. Such varieties as I. AHOR 2542/63 from Ethiopia (K-20024), Aria from Sweden (K-20508), Anadolu 86 (K-30319) and Obruk 86 (K-30320) from Turkey, L-5 Krinichniy (K-30439) from Belarus, Karabalyk 5 (K-30774) from the Chelyabinsk region, Pervotselinnik (K-30895) from the Orenburg region, Sokol (K-30827) and Zernogradsky (K-30453) from the Rostov region significantly exceeded the standard for this feature (by 4-7G).

Special attention should be paid to the samples of the collection with a complex of high indicators and exceeding the standard for yield. Their characteristics are shown below.

Pervotselinnik from the Orenburg region (K-30895): protein content of 16%, starch-59.1%, weight of 1000 grains-50.3 g, exceeding the standard yield of 10%.

Luka from the Kemerovo region (K-30899): protein content of 16.2%, starch–58.8%, weight of 1000 grains–58.1 g, exceeding the standard yield of 21%.

Thus, the samples of chaffy barley from the VIR collection grown in the Northern forest-steppe of the Tyumen region are classified into five groups according to the protein content in the grain. Most of the samples (60%) were in groups with a protein content above 14%. The average weight of 1000 grains were almost at the same level (48.3-48.7 g) in the group with low protein content and in the groups with high protein content. The starch content in the grain of barley samples was characterized by a downward trend from the group with a low percentage of protein to the groups with medium and high protein content. The starch/protein ratio was 5.3 in the low-protein group, 4.8–4.4 in the medium-protein group, and 4.1–3.8 in the high-protein group. The samples combining a high protein content with a high mass of 1000 grains, as well as high-protein samples with a high mass of 1000 grains that exceeded the standard yield by 10-21%, have been selected. These samples can become a valuable base line for creating new barley varieties in the region.

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