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FRACTIONAL AND AMINO-ACID COMPOSITION OF WHEAT GRAIN CULTIVATED IN UZBEKISTAN

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Wheat grain cultivated in Uzbekistan had an increased content of water-soluble proteinaceous and relatively low gliadin and glutelin fractions. The amino-acid content in the studied varieties depended on the amount of protein in the grain.

Key words: albumin, globulin, gliadin, glutelin.

Studies of the quantitative ratio of wheat protein fractions are important for evaluating and using the grain and determining its food value. The total protein content in the grain varies from 8 to 25.8% and depends on the genotype and growth conditions. Proteinaceous substances in wheat grain vary considerably [1].

Proteins react chemically with each other and form a single structural framework during processing of grain into flour and then into dough.

Grain proteins are arbitrarily divided into Osborne fractions (albumin, globulin, gliadin, glutelin) based on solubility in various solvents. The quantitative ratio of these fractions in grain is not constant [2].

In Uzbekistan, *Triticum aestivum* L. is the main wheat cultivar. We investigated wheat grain of varieties Andizhan 1, Andizhan 2, Yugtina, Ekho, Chillaki, Polovchanka, Umanka, Kroshka, Knyazhna, and Del′ta, which are widely used to produce flour.

Proteins were extracted successively from ground grain by solutions of salt, alcohol, and base. The total albumins and globulins were extracted by salt solutions. These proteins are considered soluble and consist of protoplasmic enzymatic proteins, functionally active proteins, enzyme inhibitors, etc. [3]. Enzymes occur in various parts of the grain and are especially concentrated in wheat germ [4, 5]. Upon mixing dough, the soluble protein fraction reacts with gluten-forming proteins and influences the quality of the final product [6].

The gliadin and glutelin protein fractions were extracted by alcohol and base, respectively. According to the literature, up to 77% of the total proteins of wheat grain fall into these fractions [7]. During mixing dough, these proteins aggregate to form a complex structural framework called gluten, upon which the baking quality of the grain depends [8]. Gliadin and glutelin are distinguished by the presence in them of a large quantity of reactive radicals. Owing to this, they can easily form various types of bonds (disulfide, H-bonds, hydrophobic interactions) with each other and become aggregated [9]. This condition of the proteins imparts to the gluten complex of wheat grain elasticity, resilience, and stretchability, properties that determine the baking quality of the flour.

Table 1 lists the quantitative contents of protein in grain and in each isolated protein fraction.

Table 1 indicates that the content of soluble proteins is elevated and the gliadin and glutelin fractions, which are the main component of gluten, are reduced in wheat grain cultivated in Uzbekistan (2001 harvest).

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TABLE 1. Fractional Composition of Proteins in Wheat Grain (% of Total Protein)

Wheat variety	Total protein content	Albumin	Globulin	Gliadin	Glutelin
Andizhan 1	14.89	21.2	5.22	43.0	27.1
Andizhan 2	14.14	20.7	5.4	43.75	26.8
Yugtina	14.43	21.26	4.73	47.0	25.0
Ekho	13.76	19.6	4.8	45.9	25.8
Chillaki	14.29	20.92	5.2	44.5	25.3
Polovchanka	14.28	19.7	6.0	43.8	26.0
Umanka	13.96	18.0	5.3	50.56	24.2
Kroshka	12.05	18.4	4.87	50.9	23.7
Knyazhna	13.25	18.64	5.0	47.67	24.9
Del′ta	13.25	18.97	5.2	46.9	25.8

TABLE 2. Chemical Composition of Wheat Grain

Wheat variety	Proteins	Fats	Cellulose	Ash	Mineral substances*						
	%				SiO_2 (Si)	MgO(Mg)	CaO(Ca)	Na_2O(Na)	K_2O(K)	P_2O_5(P)	SO_3(S)
Andizhan 1	14.9	3.2	2.05	2.13	3.35(29.0)	10.86(121.2)	3.36(44.4)	0.54(0.86)	28.95(444.1)	52.67(425.2)	0.52(3.8)
Andizhan 2	14.14	3.8	2.2	1.87	6.99(51.9)	12.3(117.93)	2.78(31.6)	0.33(3.9)	27.21(359.0)	49.41(342.9)	0.82(5.2)
Yugtina	14.43	3.7	2.0	1.80	7.41(53.7)	13.52(127.2)	2.99(33.3)	0.77(5.44)	28.91(374.4)	46.57(317.0)	1.72(1.1)
Ekho	13.76	3.9	2.3	1.80	6.00(46.3)	12.35(122.9)	2.52(29.7)	0.44(5.4)	29.05(397.0)	49.02(353.0)	1.18(7.8)
Chillaki	14.3	3.8	2.1	1.84	3.10(22.0)	13.5(120.6)	2.33(25.3)	0.34(3.83)	27.88(351.8)	51.96(344.7)	0.77(4.68)
Polovchanka	14.28	3.4	2.5	1.69	4.22(32.7)	11.61(116.2)	2.40(28.5)	0.34(4.2)	31.29(431.2)	48.59(351.6)	1.10(7.7)
Umanka	13.96	3.2	2.0	1.90	6.13(45.3)	12.09(115.9)	2.38(27.9)	0.45(5.3)	28.61(375.0)	49.58(341.9)	0.26(1.6)
Kroshka	12.0	4.3	2.7	1.90	2.60(20.7)	12.93(132.6)	2.45(29.8)	0.51(6.43)	29.27(413.0)	51.6(382.8)	0.32(2.18)
Knyazhna	13.25	4.1	2.5	1.80	8.13(58.9)	11.49(107.4)	2.71(30.0)	0.52(6.0)	29.81(383.6)	45.44(307.2)	1.47(9.1)
Del′ta	13.27	3.8	2.5	1.86	4.81(36.4)	11.9(116.3)	2.75(31.8)	0.39(3.48)	3.50(410.2)	48.98(346.0)	0.34(2.2)

*Oxides, % in ash; metal elements per 100 g wheat grain.

The total protein content is known [10, 11] to depend on the climatic conditions in the region where the wheat grows. The protein composition of wheat grain grown in Uzbekistan typically has fraction ratios in which the soluble proteins are elevated. Slight changes in other chemical properties of grain quality such as ash, lipid, and cellulose contents (Table 2) apparently are also connected to soil-chemical and climatic conditions.

According to current thinking, the technical quality of wheat grain depends on not only the protein composition but also their properties, which are intimately related to the amino-acid composition. The amino-acid composition of wheat proteins does not essentially change because it is determined genetically [12]. However, practice teaches that the food value of grain varies considerably as a result of changes in its protein composition, especially as affected by fertilizers [13]. There is also information about the role of phosphorus in increasing the protein concentration of grain [14]. The protein and amino-acid compositions of wheat have been widely studied. However, data about the amino-acid composition of wheat grown in Uzbekistan and the effect of varieties on the balance and overall value of the amino-acid composition have not been published. We determined the quantitative amino-acid content of wheat grain cultivated in Uzbekistan. Table 3 shows that the content of invidivual amino acids in the studied varieties does not vary substantially. The amino-acid content varied by 20% (Table 3). Our results for lysine determination were confirmed by published data [15, 16] on the existence of an inverse relationship between the contents of this amino acid and protein. However, this dependence is not completely proportional in our experiment. Lysine is an essential amino acid that determines the food value of the grain. From a practical viewpoint, a promising variety is one that has a relatively high lysine content with a high protein content. It was found [17] that the amount of glutamic acid increased with decreasing lysine content and increasing protein content. This dependence was observed in 4 of 10 analyzed wheat varieties. Determinations of the contents of other essential amino acids (methionine, threonine, isoleucine, phenylalanine, valine, and leucine) showed that the dependence between their and the protein contents is proportional.

TABLE 3. Amino-Acid Composition of Protein from Various Wheat Varieties, g/100 g Protein

Wheat variety	Amino acid																	
	Asp	Thr	Ser	Glu	Pro	Gly	Ala	1/2Cys	Val	Met	Ile	Leu	Tyr	Phe	His	Trp	Lys	Arg
Andizhan 1	4.2	2.5	4.2	35.0	10.2	3.7	3.5	2.4	5.2	2.5	3.2	6.3	3.1	3.9	1.8	1.8	4.6	4.9
Andizhan 2	4.0	2.5	4.1	33.5	10.0	3.5	3.3	1.8	4.7	2.3	3.6	6.7	3.0	5.1	1.7	1.8	4.9	5.2
Kroshka	4.7	2.9	4.5	34.7	10.4	3.7	3.7	2.2	5.1	2.0	4.1	7.0	3.2	6.4	1.9	2.0	3.9	5.3
Del′ta	4.5	2.8	3.7	33.0	10.0	4.7	4.0	2.3	4.0	2.3	3.3	6.6	3.0	6.0	2.2	2.0	4.2	5.0
Chillaki	5.1	2.8	4.0	35.0	9.6	4.0	3.8	2.1	4.4	1.5	3.1	6.2	3.0	6.2	1.5	1.9	4.1	5.3
Ekho	4.4	2.4	4.3	32.3	10.5	4.2	3.8	2.0	3.6	0.9	2.5	6.1	1.8	4.1	1.8	1.8	4.5	3.0
Knyazhna	6.0	2.7	5.0	28.9	9.8	5.0	4.2	1.9	6.2	1.9	2.7	6.9	2.3	5.7	2.0	1.8	5.0	4.2
Polovchanka	4.0	2.3	3.1	33.8	10	3.8	2.5	2.0	5.8	2.4	3.6	7.7	2.0	6.2	2.1	1.8	3.15	4.7
Umanka	4.2	3.9	4.5	29.7	9.8	3.5	3.7	1.6	4.8	1.9	2.4	7.5	2.4	6.0	1.9	1.9	3.7	5.9
Yugtina	5.0	2.9	5.0	34.0	10.2	4.6	3.0	2.0	5.6	2.5	3.3	7.2	1.9	6.3	2.0	1.9	4.5	5.5

Thus, the protein composition of 10 wheat varieties was studied. It was found that Andizhan 1, Andizhan 2, Chillaki, Yugtina, Polovchanka, Umanka, Ekho, Knyazhna, and Del′ta have high protein contents. The albumin and globulin fractions have elevated protein contents. The amino-acid composition of grain proteins in the studied samples contains the whole spectrum of amino acids that is typical for wheat grain and is directly proportional to the protein content.

EXPERIMENTAL

Wheat grain was thoroughly ground to produce a powder. Each sample (1 g) was extracted by KCl solution (0.1 M, 1:20 ratio) for 1 h on a magnetic stirrer and centrifuged for 15 min at 6000 rpm. The supernatant contained the soluble-protein fraction, albumin and globulin; the precipitate, gliadin and glutelin. The precipitate was extracted by alcohol solution (10 mL, 70%) and centrifuged. The gliadin protein fraction was located in the solution. The precipitate was extracted with base solution (0.1 M NaOH) to separate the glutelin protein fraction.

The protein contents were calculated by the Kjeldahl method [18]; lipids, by determining the oil from the mass of dry defatted solid [18].

The cellulose content was determined by the usual method [18]; ash, by combusting the sample according to GOST 13979.6-68.

The amino acids were analyzed on an AAA-400 (Czech Rep.) amino-acid analyzer. Samples (5 mg) were hydrolyzed in HCl (5.7 N) in sealed ampuls for 24 h at 110°C.

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