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RATIO OF PROTEIN FRACTIONS IN CEREAL GRAINS CULTIVATED IN UZBEKISTAN

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The glutelin fraction was used as the food value index of local corn. The base-soluble fraction was used as a test of the glassiness of local strains of rice grain. The content of gliadins and glutelins did not change over 24 h after wheat grain cultivated in Uzbekistan was moistened.

Key words: cereals, variety, fractional composition, glutelins, essential amino acids, grain protease.

Total protein of grain can be unbalanced due to the presence of fractions that are extremely poor in certain essential amino acids. Therefore, special attention should be paid not only to increasing the protein content but also to the redistribution of protein fractions [1, 2] and the quality and quantity of protein in corn [3, 4] when selecting cereal grain cultures.

Corn is a cereal with a relatively low protein content, approximately 10% of the whole grain. The protein content tends to fall during production of high-lysine hybrids. In particular, a study of the fractional protein composition of corn validates the selection of parental forms in creating high-lysine strains. The zein fraction does not contain lysine whereas the glutelin content reaches 4.7 g per 100 g of protein [3].

We investigated strains of corn cultivated in Uzbekistan, e.g., popcorn, a primitive form; flint, a silage strain; sweet, a selection strain (Table 1); and hybrid strains dent Uzbekistan 601 ECB, late-ripening strain dent Uzbekistan 306 AMB, a middle-late ripening strain, and a new hybrid dent Uzbekistan 420. Of all strains, a primary content of glutelin compared with other fractions in each strain was observed only in hybrids dent Uzbekistan 306 AMB, Uzbekistan 601 ECB, and dent Uzbekistan 420. The sweet strain had an idential content of all protein fractions. The zein fraction was greater than that of glutelin in the usual corn strains, popcorn and flint.

Therefore, a high lysine content in the amino-acid composition can be expected only in the hybrids Uzbekistan 306 AMB, Uzbekistan 601 ECB, and dent Uzbekistan 420. Any increase in the glutelin fraction owing to zein not only increases the food value of corn protein but also solves the problem of the effectiveness of corn processing technology because just the glutelin fraction supports the endosperm structural matrix [4].

Amino-acid analysis of the proteins in strains studied by us confirmed the fractional compositions. Only hybrids and the sweet strain had high lysine contents in which primarily the glutelin fraction was observed upon fractionation (Table 1). Furthermore, the new hybrid Uzbekistan 420 inherited a high glutelin-fraction content from the parental strains (lines 1812 and 3928), the amino-acid composition of which had a high lysine content. Local corn strains typically have a relatively low prote in content. Production of high-lysine hybrids tends to decrease its content. Therefore, the amount of protein, the ratio of protein fractions, and the amino-acid and chemical compositions of corn grain change as a function of the genetic features of the strain and the growing conditions.

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TABLE 1. Fractional and Amino-Acid Compositions of Proteins from Corn Cultivated in Uzbekistan

Index	Corn strain							
	popcorn	flint	dent Uzbekistan 601 ECB	sweet	dent Uzbekistan 306 AMB	line 1812	line 3928	dent Uzbekistan 420
Protein fraction, mg per wt.								
Albumins	117	32.23	38.1	244.7	29.11	Σ67.60	Σ45.12	Σ54.0
Globulins	250.5	578.2	72.3	308.2	38.85			
Zeins	252.3	397.9	247.7	360.5	212	97.5	118.8	108.8
Glutelins	140	241	309.1	369.8	272.6	253.9	258.75	200.4
Total protein	9.17	8.63	10.77	11.25	11.91	10.88	10.0	6.5
Amino acid, wt. %								
Asp	3.1	3.1	1.3	3.7	2.3	5.9	3.1	1.6
Thr	1.1	1.0	0.6	1.8	1.5	2.3	1.5	1.0
Ser	1.2	1.0	0.8	1.8	2.0	2.7	1.8	0.9
Glu	5.8	7.0	6.2	7.6	6.9	4.0	1.5	2.3
Pro	1.2	1.0	1.9	1.3	3.3	2.9	0.6	1.9
Gly	1.7	1.3	2.5	1.8	2.3	3.2	1.1	2.3
Ala	1.0	1.3	2.1	1.6	2.5	2.9	0.7	3.1
Val	1.7	1.3	2.3	1.8	2.3	3.0	0.5	2.4
Met	0.2	0.3	0.5	0.5	0.9	0.6	1.3	1.7
Ile	1.6	1.3	2.3	1.8	2.6	2.9	1.3	1.4
Leu	3.5	3.7	6.4	3.3	7.0	5.6	1.8	1.6
Tyr	1.6	1.3	2.3	1.7	1.8	3.1	3.0	5.2
Phe	2.8	2.1	4.4	3.5	2.7	6.6	3.2	5.8
Trp	-	-	-	-	-	-	-	-
Lys	1.2	1.0	3.1	2.5	3.4	4.1	3.2	3.7
Arg	6.4	4.9	6.1	7.6	3.7	4.7	4.4	2.3
Cys	-	-	-	-	-	-	-	1.6
His	1.7	1.5	1.4	1.4	2.0	1.9	5.2	1.4

Nitrogenous compounds are second in quantity among the reserve compounds of rice grain and are represented by simple and complex compounds. The former include amino acids, amino-acid amides, glutathione, etc.; the latter, albumins, globulins, prolamins, and oryzenins. The quality of rice is determined mainly by the fracturing. One of the factors affecting fracture formation is the chemical composition of the rice grain. Highly glassy grain with a high protein content is the most stable to fracture formation. An attempt was made to give certain recommendations for rice processing based on a study of the quantitative content of total protein and its fractional composition in local strains.

We investigated the high-yield strains Avangard, a new promising strain Alanga, late-ripening Marvarid, super-elite Mustakillik, and the long-grain strain Azure that was developed by Uzbek selectionists.

A comparative quantitative evaluation of proteins in glassy strains (Avangard, Mustakillik) found a high protein content in them, 12.93 and 11.5%, respectively (Table 2). The fractional protein composition in these strains was characterized by a tendency of the water- and salt-soluble fractions to decrease whereas the base-soluble fraction (oryzenin) increased. This turned out to be atypical for the fractional composition of rice grain with a low protein content, e.g., Alanga, Marvarid, and Azure, which contain 7.71, 7.76, and 7.5% protein, respectively. Therefore, the base-soluble fraction is a test for rice-grain glassiness.

TABLE 2. Fractional and Amino-Acid Compositions of Rice Grown in Uzbekistan

Index	Rice strain				
	Avangard (elite)	Alanga (middle-late ripening)	Marvarid (late ripening)	Mustakillik (super-elite)	Azure (long-grained)
Protein fraction, mg per wt.					
Albumins	9.8	19.8	24.2	6.6	17.6
Globulins	127.4	193.6	173.8	118.3	244.2
Prolamins	25.0	37.05	18.7	38.83	75.0
Glutelins	253.6	207.3	214.4	264.0	219.6
Total protein, %	12.93	7.71	7.76	11.5	7.5
Amino acid, wt. %					
Asp	0.5	0.4	0.4	0.7	1.0
Thr	0.4	0.3	0.5	0.6	0.1
Ser	0.2	0.3	0.4	0.2	0.9
Glu	3.0	0.3	0.4	1.0	0.7
Pro	1.4	0.6	-	-	-
Gly	0.6	0.3	0.4	0.2	0.3
Ala	0.5	0.3	0.4	0.2	0.3
Val	0.8	0.6	0.9	0.6	0.4
Met	0.5	0.1	0.2	0.4	0.7
Ile	0.6	0.2	0.2	0.4	0.4
Leu	0.7	0.4	0.4	0.4	0.7
Tyr	0.6	0.5	0.5	0.5	0.5
Phe	0.8	0.3	0.6	0.7	0.9
His	0.5	0.7	0.3	0.1	0.3
Lys	1.6	0.6	0.6	1.0	0.6
Arg	0.9	1.0	1.5	1.0	4.5

It is known that the smaller fraction has a higher oryzenin content [5] whereas the fracturing is more extensive in the larger fraction of rice-grain. These indices in combination with our data have led to the recommendation that it is advisable to dry rice-grain fractions separately according to size. Therefore, the content of glassy, fractured grain and protein is not by chance most significant for determining the processing value of rice-grain.

Among cereals, rice has total protein that is the most balanced in amino-acid composition. The amino-acid composition of local strains indicates that the high-protein strains Avangard and Mustakillik have comparatively high contents of essential amino acids and typically have a glutelin fraction that is dominant.

The biological system of wheat grain that is awakened upon moistening reacts to changes of external conditions more responsively with subsequent drying and exhibits a higher activity. Moistening the seeds above 20% and subsequent drying increases the seed value of the grain. Certain high-protein strains with high-quality gluten give a low bread volume because of a deficiency in the flour of soluble proteins, e.g., albumins and globulins.

Therefore, we studied the quantitative content and fractional composition of proteins in the wheat grains Princess, Echo, Chillaki, and Polovchanka cultivated in Uzbekistan. We investigated grain that was dry and ripe and that was moistened for 24 h. Using protein fractionation methods (Table 3), we found that the high-molecular-weight components gliadin and glutelin did not disappear after 24 h of moistening. Therefore, the flour did not lose its ability to give an elastic gluten.

Proteolytic enzymes are connected to a large extent with gluten proteins [6]. Therefore, we evaluated comparatively the proteolytic activity of grain that was ripe and dry and that was moistened for 1 d (Table 3). We found that the protease activity increased during these hours of rising. Therefore, it could be concluded that not only fungal and bacterial but also yeast enzymes can be excluded.

TABLE 3. Fractional Composition of Proteins and Proteinase Activity in Ripe Dry and Moistened for 24 h Wheat Seeds, mg per wt.

Variety	Albumins		Globulins		Gliadins		Glutelins		Proteins, %		Activity, units/g	
	1	2	1	2	1	2	1	2	1	2	1	2
Princess (Fergan valley)	51.6	50.4	260.8	339.0	114.0	149.0	30.8	35.2	14.82	15.11	10.4	16.53
Echo (Andizhan)	39.0	52.9	286.6	311.6	126.0	156.8	30.0	36.25	14.36	14.92	2.93	3.47
Chillaki (Andizhan)	45.6	40.3	306.4	510.8	169.4	182.5	25.0	31.0	13.22	15.93	5.07	9.33
Polovchanka (Namangan)	56.0	58.0	247.0	390.1	114.4	132.3	25.0	27.5	14.82	15.32	4.00	8.53

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1) dry seeds; 2) moistened.

The addition of various natural products that contain significant quantities of vitamins, minerals, and proteins to the flour is recommended to increase the food value of the bread. Up to 25% of the most valuable protein is discarded in the siftings for flour that is 70% ground.

Our investigations show that wheat grain that is moistened for 1 d should be used to enrich the bread. Samples of bread baked from this whole grain did not have typical defects and had normal softness.

Thus, protein fractionation revealed differences in the relative amounts of zein and glutelins. This explains the food value of local strains of high-lysine corn compared with the usual ones. Any increase of the glutelin fraction over zein increases the food value of the corn protein. The fractional composition of high-protein (glassy) local strains of rice typically had water- and salt-soluble fractions that tended to decrease and a base-soluble fraction (oryzenin) that increased. Oryzenin is a test of the glassiness of rice grain. Wheat grain cultivated in Uzbekistan had a protein content in the soluble fraction that was greater than that of the gliadin and glutelin fractions. This characteristic property of local wheat-grain strains is viewed for the first time as an ability to use enzymes of the water-soluble fractions to bake bread from whole grain.

EXPERIMENTAL

Cereal protein was fractionated as before [1].

Protein content was determined quantitatively by the Kjeldahl and Warburg—Christian methods [7] on a SF-46 spectrophotometer; amino-acid composition, on a T-339 analyzer; proteolytic activity, by the literature method [9].

Samples were hydrolyzed in HCl (5.7 N) in vacuum for 24 h at 110°C.

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