Journal of Engineering and Applied Sciences 13 (Special Issue 10): 8292-8299, 2018
ISSN: 1816-949X

Features of Technological Properties of Triticale Grain of Kazakhstan's Selection

[1]K.K. Zhanabayeva, [1]N.O. Ongarbayeva, [2]G.A. Ruchkina, [3]G.K. Yesseyeva and [4]V.L. Smolyakova
[1]Almaty Technological University, 100 Tole bi, 050012 Almaty, Kazakhstan
[2]Kostanai State Pedagogical Institute, 118 Tauelsizdik, 110000 Kostanai, Kazakhstan
[3]Kostanai Engineering and Economics University Named after M. Dulatov, 59 Chernyshevsky, 110000 Kostanai, Kazakhstan
[4]Kostanai State University A. Baitursynov, 47 A. Baytursynov Street, 110000 Kostanai, Kazakhstan

Abstract: As a result of the research, the technological features of the triticale grain of Kazakhstan's selection have been experimentally determined: physico-chemical, biochemical and flour-grinding properties. Based on the planning of experiments interrelation between the quantitative and qualitative indices of individual varieties of triticale grain was established. The optimal modes of the process of cold conditioning of grain of experimental varieties are determined. In addition, optimal grinding modes were determined when grinding grain samples for the I break system -35-40%, for the II break system -45-50%, for the III break system -35-40%. It is noted that in the process of grinding and forming the quality of triticale flour from the central part of the endosperm of grain by processing the cereal on the sieve purifier, it will give a real opportunity to obtain special flour with specified properties.

Key words: Triticale, cold conditioning, cereal-forming ability, granulometric composition, fractions, technological characteristics

INTRODUCTION

Grain is the basic raw material for the production of flour, cereals, bakery and flour confectionery products that ensure the food security of any country. Considering the promising areas of use, triticale can take a worthy place among the main grain crops. It is produced mainly in a number of countries such as Poland, Germany, France, Russia, Belarus, Australia, Canada and Brazil (Vitol *et al*., 2016).

According to forecasts in the future triticale will become one of the leading cereal crops in the world, since, it contains the essential amino acid lysine which fully characterizes its nutritional and biological value. According to the content of lysine, triticale considerably exceeds wheat. This is important, since, most of the world's population currently suffers from improper feeding and malnutrition. Protein-caloric deficiency in children is one of the most important problems in developing countries. To solve this problem, special attention should be paid to the elimination of varieties of grain crops with high protein content (Vitol *et al*., 2016; Gold, 1967).

The use of triticale will ensure the nutritional and biological value of finished products. To date in the Republic of Kazakhstan produce flour of various varieties mainly from wheat and rye and no triticale grain is used (Ongarbayeva *et al*., 2016).

On the territory of the Republic of Kazakhstan, Winter varieties of triticale Taza Orda and Balausa, grown in the South of the country were recommended for cultivation (Ongarbayeva *et al*., 2016).

At present, the advantages of triticale grain as a biologically valuable raw material in the food industry are not fully explored and evaluated. This is due to the lack and inconsistency of information on new varieties of triticale, on its microstructure, biochemical, physico-chemical and other properties of modern varieties created by Kazakhstan breeders. As a result in The Republic of Kazakhstan, the culture of triticale has not been properly applied. Its technological features as a raw material for the production of flour have not yet been fully studied. These circumstances force the carrying out of experimental studies on the study of the qualitative characteristics of the triticale grain of Kazakhstan selection (Singer, 1938).

The choice of optimal conditions for grain processing can be made only on the basis of exhaustive data on its qualitative potential including its technological properties.

Corresponding Author: K.K. Zhanabayeva, Almaty Technological University, 100 Tole bi, 050012 Almaty, Kazakhstan

Due to the lack of regulatory data of the organization and management of technological processes for processing finished products, it is necessary to conduct research on the study of the characteristics of the triticale properties of Kazakhstan selection and the effectiveness of its use in the food industry (Martin and Sole, 2008; Pankratov *et al*., 2016).

Therefore, the study of the dispersion and granulometric composition of triticale flour, the study of their dependence on the quality of flour and finished products is necessary today. It is especially, important to study the dispersion of flour by a direct microscopic method which makes it possible to obtain a quantitative estimate of the size of flour particles.

MATERIALS AND METHODS

The object of the study was the varieties of triticale grain of Kazakhstan's selection of Taza Orda and Balausa which are recommended for cultivation in the territory of The Republic of Kazakhstan and allowed to be used in Almaty, Zhambyl and Shymkent Regions.

In evaluating the quality characteristics of triticale grain and flour samples obtained, conventional standard methods and modern laboratory instruments and installations were used: diaphanoscope, liter scale, SKCS 4100 Perten Instruments, Glutomatik, IDK-1, device Pacific Scientific 4250 and polarimeter, Falling Number.

The microstructure investigation was carried out on a scanning electron microscope of the brand Jeol JSM-35C (Japan) at a magnification of 150-4000 times. The correlation dependence of qualitative indicators was calculated using the "Statgraphics+" Software package.

The analysis of grain leveling and grain size of the investigated samples was carried out with the help of sieve analysis. In this case, a set of laboratory sieves with oblong holes was used: 3.0×20; 2.8×20; 2.5×20; 2.2×20; 2.0×20; 1.7×20; 1.4×20.

To select the optimal ratio of the cold conditioning modes, the central compositional planning for the second-order 2^2 experiment was performed, the "Star field".

Preparation of grain for grinding was carried out in accordance with the "Rules for the organization and management of the technological process in mills" using the cold conditioning method (Bystrov *et al*., 2017).

To study the cereal-forming ability of the experimental samples of triticale grain, grinds were carried out on a laboratory roller mill QC-104. The test samples were moistened in two stages. All samples of grain after laying down before the direction were additionally moistened by 0.3-0.5% and laid aside for 20-30 min. The size of the extraction was determined by grinding the grain samples with an approximately established gap between the rollers.

Grinding of the grain was carried out on a laboratory roller mill "MLU-202" intended for obtaining 68-70% yield of flour and having three breakes and three grinding systems. The grinding modes were selected in such a way that during a single grain transfer the yield of flour was 68, ..., 70%. The optimum specific load of -6 kg/h was established by conducting a series of preliminary grinds.

Fractionation of triticale flour was carried out at the laboratory dawn of RL-3M brand using standard nylon and metal-woven sieves with mesh size (im): 260, 190, 140, 125, 100, 80,60, 50, 40. The particle size of the descent of the product from a certain sieve corresponded to the size of its mesh.

Grinding size of flour was determined by the remainder and the pass through 1 or 2 sieves of the appropriate size, established by the regulatory documentation for each variety of flour.

The granulometric composition of the flour was determined by sieving it on sieves with mesh of different sizes.

RESULTS AND DISCUSSION

Table 1 shows the grain samples of triticale grain taken for the study. From Table 1, it can be seen that the grain of the Taza variety is designated by the No. 1-4, grain of the variety Orda under the No. 5-8, grain of the Balausa variety under the No. 9-12 depending on the growing conditions.

The qualitative characteristics of the triticale grain samples taken for the study are given in Table 2. The

Table 1: Samples of grain varieties of triticale cultivated in the South of Kazakhstan

Sample No.	Variety	Region of cultivation
1	Taza	Almaty
2	Taza	Almaty Bogara
3	Taza	Zhambyl
4	Taza	South (Shymkent)
5	Orda	Almaty
6	Orda	Almaty Bogara
7	Orda	Zhambyl
8	Orda	South (Shymkent)
9	Balausa	Almaty
10	Balausa	Almaty Bogara
11	Balausa	Zhambyl
12	Balausa	South (Shymkent)

Table 2: Quality indicators of the samples

Sample No.	Quality indicators: Grain unit (g/L)	Vitreousness (%)	Humidity (%)	Mass of 1000 grains (g)	Gluten (%)	Grain hardness (Ha)	Protein (%)	Starch (%)	Fat	Cellulose (%)	Ash content (%)
1	691	39	12.1	42.1	18.9	44	12.4	63.5	1.8	0.9	1.39
2	679	59	11.8	39.4	20.8	87	12.8	61.2	1.7	1.1	1.84
3	696	76	12.2	51.0	21.5	88	13.9	68.0	1.9	1.0	1.74
4	637	77	12.6	43.4	21.0	95	13.7	67.5	2.2	0.8	1.64
5	726	45	12.3	40.2	no	26	9.8	62.0	1.9	1.6	1.98
6	722	58	11.9	41.3	no	29	10.9	63.1	2.3	1.8	1.77
7	751	74	12.4	43.0	20.3	31	12.0	64.2	2.0	1.3	1.81
8	637	53	11.7	33.7	21.8	39	12.6	58.7	1.9	1.9	1.91
9	627	44	12.2	38.8	no	20	9.4	60.9	2.1	2.1	2.00
10	651	67	13.0	33.2	13.6	35	11.0	57.4	1.8	2.5	2.01
11	699	48	12.5	35.0	13.2	28	10.9	67.6	2.2	1.9	1.97
12	680	55	12.7	21.1	18.5	38	11.9	56.7	1.7	2.3	2.06

results of the experiments (Table 2) showed that the qualitative characteristics of the triticale cultivars studied in Southern Kazakhstan combine the values of the indices inherent in rye and wheat.

Analyzing the data of Table 2, it should be noted that sample No. 3 (Zhambyl Region), a larger granule with developed endosperm, grain hardness and vitreousness -88 Ha and -86%, respectively, differed from samples of Taza variety with a maximum mass of 1000 grains and in terms of grain content protein -13.7%, gluten -24.5%, starch -68.0%, fat -1.9%, cellulose -1.0% and ash content -1.74%.

In general, the quality indicators for samples the triticale grain of Taza variety are higher than those of the Orda and Balausa varieties.

The maximum mass of 1000 grains from samples of the Orda variety -43.0 g is sample No. 7 with grain hardness -31 Ha andvitreousness -94% with the grain unit -751 g/L. In sample No. 7, the protein content in the grain is 12.0%, gluten -28.4%, starch -64.2%, fat -2.0%, cellulose -1.3% ash content -1.81%.

Sample No. 11 differed from samples of varieties Balausa by the greatest mass of 1000 seeds -45.0 g., high vitreousness -88%. The grain hardness of the sample No. 11 was 28 Ha and the protein content in the grain was 11.9, gluten -22.5%, starch -67.6%, cellulose -1.9%, fat -2.2 and ash content -1.97%.

All the samples under study were subjected to a dry state in the moisture content of the grain up to 13.0% and by weediness of weed and grain impurity to a net to 1.0 and 2.0%.

To establish the relationship between the indicators, the coefficients of pair correlation were calculated. The significance of the correlation coefficients is verified with a reliability of output of not <0.95. At the same time, a close relationship was established between the following parameters: the mass content of 1000 grains and starch (r = 0.745), grain hardness content and protein

Table 3: Correlation and regression between grain quality signs of triticale

Correlation signs	Correlation coefficient	Regression equation
Mass of 1000 grains-starch	0.745	Y = 0.39x+47.45
Grain hardness, Ha-protein (%)	0.737	Y = 0.04x+10.12
Vitreousness, (%)-protein (%)	0.681	Y = 0.08x+7.16
Gluten (%)-protein (%)	0.638	Y = 0.05x+11.35

Table 4: Leveling and size of samples of triticale grain

Sample No.	Leveling (%)	Size (%) (overs of sieve 2.5×20)	The content of fine grains, % (pass 2.0×20 /overs 1.7×20)
1	75.2	82.1	0.93
2	74.6	78.6	1.13
3	77.0	83.5	1.20
4	73.8	82.1	0.90
5	67.4	76.4	1.30
6	68.8	77.7	1.20
7	76.5	75.7	0.93
8	76.1	75.6	1.61
9	57.8	53.0	0.73
10	60.1	55.0	1.30
11	58.2	49.0	1.40
12	55.6	51.0	0.76

(r = 0.737), vitreousness and protein (r = 0.681), gluten content and protein (r = 0.638). It is also observed that a positive interrelation of the average force is established in grain hardness with the content of starch, the mass of 1000 grains with hardness and vitreousness.

With the rest of the indicators, the relationship is either positive or negative. The regression equations were calculated by us for signs whose correlation is high and the relationship is significant (Table 3).

The obtained results on the study of the leveling and size of the investigated triticale grain samples are given in Table 4 and are reflected in Fig. 1 and 2.

The analysis of the obtained data (Table 4) shows that the grain of the Taza variety (No. 1-4) was classified as medium-sized in size (the largest total weight on 2 adjacent sieves No. 2.8×20, No. 2.5×20 in percent to the initial sample weighs from (73.8-77.0%) and large. The overs of sieves No. 2.5×20 lies in the range of 78.6-83.5 %.

Table 5: Average values of the fractions by size of the samples of triticale grain

No. of sieve	1	2	3	4	5	6	7	8	9	10	11	12
1	2	3	4	5	6	7	8	9	10	11	12	13
3.0×20	8.88	4.00	6.50	8.30	9.00	6.00	6.21	7.65	5.50	7.20	12.54	5.74
2.8×20	55.10	36.20	23.50	48.70	35.50	34.23	12.19	8.10	20.22	5.15	6.11	29.80
2.5×20	20.10	38.40	53.54	25.06	31.90	34.31	57.30	59.90	27.27	42.65	30.35	15.46
2.2×20	14.30	11.14	13.00	13.60	11.90	16.03	19.23	16.24	30.53	17.45	27.85	40.14
2.0×20	2.69	9.13	2.28	3.04	10.40	4.00	4.14	6.50	15.75	26.25	21.75	8.10
1.7×20	0.31	0.79	0.84	0.52	0.70	0.60	0.46	0.86	0.63	0.54	0.50	0.50
1.4×20	0.42	0.32	0.15	0.20	0.50	0.50	0.02	0.51	0.01	0.70	0.70	0.06
Screen bottom	0.20	0.02	0.19	0.40	0.10	0.10	0.45	0.24	0.09	0.06	0.19	0.20

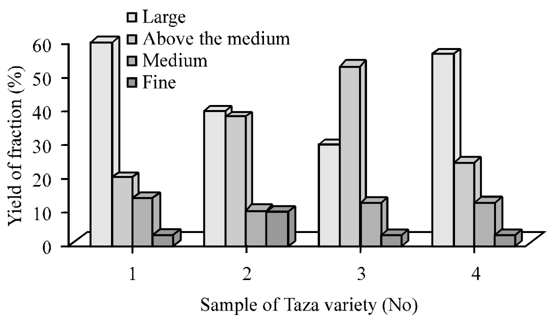

Fig. 1: Histogram of distribution of grain fraction of Taza variety

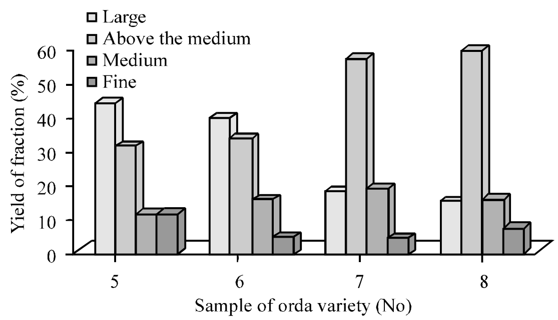

Fig. 2: Histogram of distribution of grain fraction of Orda variety

Samples of the Orda variety No. 5 and 6 were classified as low (the largest total weight on 2 adjacent sieves No. 2.8×20, 2.5×20% to the initial sample was 67.4 and 68.8%, respectively) but the large. The overs of sieves No. 2.5×20 are in the range of 75.6-77.7%. And samples No. 7 and 8 were classified as medium-leveled (the total weight on two adjacent sieves No. 2.8×20, 2.5×20% was 76.5 and 76.1%, respectively.

The leveling in the sizes of samples Balausa variety was classified as low (highest total weight on two adjacent sieves is a 2.5×20, 2.2×20 lies in the range of 55.6-60.1%) and the fine overs of sieve No. 2.5×20 lies in the range of 49-55%.

Proceeding from the notion of large, medium and fine grain on the remains of the sieves, the content of different size fractions in the studied batches of triticale was determined. The average values of the fractions of the investigated triticale grain samples by size are set in Table 5 and in Fig. 1-3.

In accordance with Fig. 1, it was found that the size of samples of the large fraction Taza variety is an average of 47.8%, above the medium size of 34.3%, the medium size is 13.01 and the fine fraction is 5.17%.

According to the samples of the Orda variety (Fig. 2), the size of the large fraction is 24.77% on average, above the medium size of 45.8%, the medium size is 15.8 and the fine fraction is 7.27%.

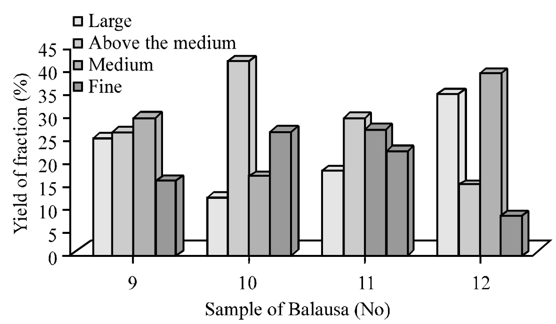

Fig. 3: Histogram of distribution of grain fraction of Balausa variety

Based on the Balausa variety samples (Fig. 3), the size of the large fraction is 23.06% on average, above the medium size of 28.92%, the average size is 29 and the fine fraction is 18.9%.

Proceeding from the concepts of the microstructure features of the grain, the microstructure of the endosperm largely determines the flour-grinding properties of the grain. For many cereal crops, it was confirmed that the microstructure of the endosperm and the technological properties of the grain are in close relationship.

Proceeding from this, microscopic studies of the endosperm structure of Kazakhstan varieties of triticale grain were carried out.

When considering the sections of the investigated triticale grain varieties presented in the figure, some

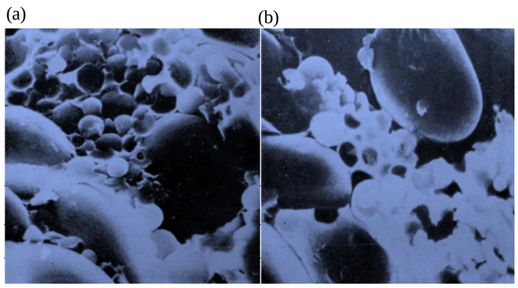

Fig. 4: The microstructure of the cells of triticale grain endosperm; a) Microstructure of endosperm of mealy triticale grain and b) Microstructure of endosperm of vitreous triticale grain

features of the endosperm structure are noted. Triticale endosperm has a structure typical of cereal crops which are prismatic cells, their dimensions vary considerably, they are filled with spherical starch grains but polygonal shapes also occur.

The pictures of the Fig. 4 shows the difference in the structure of the vitreous and mealy endosperm of triticale grain.

In the triticale grain, the mealy consistency of the endosperm basically deposits fine-grained starch, located among themselves in the form of nests. From the fallen starch grains in the protein matrix there are depressions. The structure of the endosperm is loose, the connection between the grains of starch and the protein matrix is fragile.

Structural elements of endosperm cells of vitreous triticale grain are characterized by larger granules of starch andfine granules are contained insignificantly. A characteristic feature of the microstructure of the vitreous endosperm cell is the presence of a continuous protein matrix.

The developed porosity of the structure of triticale grain endosperm indicates its increased hygroscopicity which can have a significant impact on the process of moisture during Hydrothermal Processing of grain (HTP) which serves as the basis for preparing it for processing. It has been proved that the high water absorption capacity of the outer cover of triticale grain significantly affects the degree of moisture increment in the grain when moistened.

The carried out studies of the moisture absorption of triticale grain were the basis for the choice of cold conditioning modes. To study this issue, we determined the increment of moisture in the grain of 12 samples of triticale grain with various quality indices among which the determining factor was the vitreousness. Values of vitreousness were

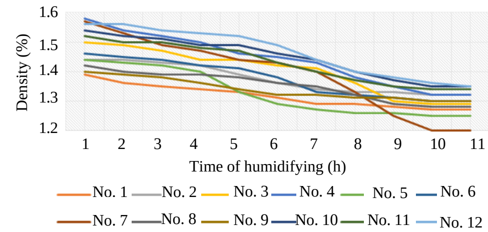

Fig. 5: Influence of the duration of humidifying to density of triticale grain

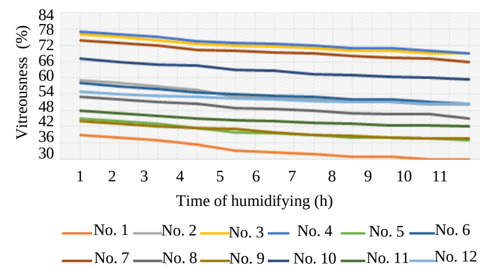

Fig. 6: Influence of the duration of humidifying to vitreousness of triticale grain

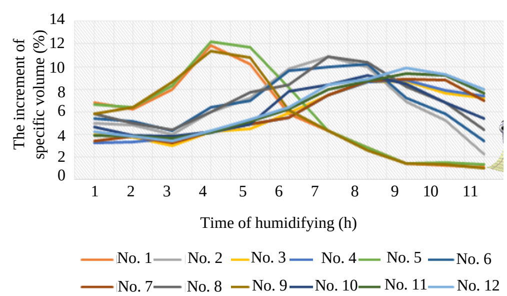

Fig. 7: Influence of the duration of humidifying to the increment of specific volume of triticale grain

from 39-78%. To quantify the changes in the grain structure during the conditioning process, the specific grain volume was used, the increment of which served as a measure of the degree of loosening of its endosperm.

During the research, the grain samples were moistened to a moisture content of 16% with an interval of 0.5% with a duration of 3 h of humidifying and were set aside for 1-10 h at intervals of 1 h. The results of the studies are shown in Fig. 4-7.

In all samples initially the moisture content was at the same level up to 13%. The most structural changes in the grain, depending on the vitreousness, occurred when it was moistened in the range from 14.5-16%. With this sampling vitreousness of the investigated grain samples

Table 6: Recommended cold conditioning modes for samples of triticale grain

Initial humidity of grain (%)	Vitreousness (%)	Basic moistening of grain: Moistenin (%)	Basic moistening of grain: Humidifying (h)	Moistening of shells of grain before I br.s.: Moistening (%)	Moistening of shells of grain before I br.s.: Humidifying (h)	Moistening of grain on I br.s. (%)
Up to 14.0	<40	14.0-15.0	4-5	0.3-0.5	20-60	14.5-15.0
Up to 14.0	40-60	15.0-15.5	6-7	0.3-0.5	20-60	15.0-15.5
Up to 14.0	more than 60	15.5-16.0	8-9	0.3-0.5	20-60	15.5-16.0

Table 7: Cereal-forming ability of investigated samples of triticale grain

Sample No.	Vitreousness (%)	Yield from I-III break systems: Large grains (%)	Medium and fine grains (%)	Dunsts (%)	Flour (%)	Total extraction (%)	Weighted average ash content (%)
1	39	19.5	32.6	8.50	9.30	69.9	1.04
2	59	22.2	34.2	8.20	9.40	74.0	1.05
3	76	27.2	32.0	9.20	8.20	77.2	0.94
4	77	27.4	30.9	9.30	8.80	76.4	1.00
5	45	20.9	29.7	7.90	10.00	68.5	1.02
6	58	22.0	27.4	8.40	10.10	67.9	1.06
7	74	25.9	32.7	8.50	9.40	76.5	0.97
8	53	21.9	29.1	7.90	10.00	68.9	1.01
9	44	20.3	28.2	10.00	9.50	68.0	1.09
10	67	25.9	22.3	9.50	10.20	67.9	1.15
11	48	21.5	26.1	9.10	10.20	66.9	1.08
12	55	23.9	26.4	9.80	9.70	69.7	1.16

has a significant effect on the rate of moisture absorption the absorption of moisture by a grain with a smaller vitreousness occurs faster.

There is a decrease in vitreousness and grain density, depending on the duration of the humidifying, most significantly this occurs with an increase in the duration in the interval from 4-9 h of humidifying. This is clearly seen from the illustrations of Fig. 5 and 6.

There is a close dependence between the duration of humidifying and the vitreousness of the initial properties of the grain. For grains with greater vitreousness, the duration of humidifying is greater.

The influence of the duration of the humidifying on the increment of specific volume shown in Fig. 7, reflects the process of loosening the endosperm, the speed of which depends on its structure. The end of structural transformations corresponds to the greatest loosening of the endosperm. The endosperm active loosening process is completed for the samples in the range of 4-9 h, taking into account their vitreous properties.

Due to the fact that the initial grain vitreousness has a significant impact on the duration of humidifying, grain triticale was classified into three groups of vitreousness: up to 40%, from 40-60%, from 60% or more.

It is noted that at grain moisture in the range from 14.5-16.0% there is the greatest decrease in grain vitreousness and its density and at more than 16% there is a slight decrease. The optimum technological moisture of the grain is determined by the degree and rate of loosening of the endosperm.

Studying the influence of the degree of moistening and duration of humidifying on structural changes of the grain endosperm, we recommended the indicative modes of cold conditioning the samples of triticale grain (Table 6).

Flour grinding properties of grain are characterized by a set of indicators of which the most important are: the quantity and quality of the cereals obtained on the systems of cereal formation, the grinding of grain, the specific energy consumption, the total yield of flour and its quality. One of the main stages in the grading is the process of cereal formation, the task of which is to obtain the maximum quantity of intermediate products of high quality.

In the process of carrying out the experimental grinding tests of the triticale samples for each of the first three break systems, the quantitative and qualitative characteristics of the grinding products presented in Table 7 were determined.

The data of Table 7 show that the greatest number of good quality croup-denser products was obtained from samples of triticale grain No. 3 and 7 with the lowest ash content of 0.94 and 0.97%, respectively.

Depending on the initial properties of the grain, the yield of croup-denser products varied from 66.9- 77.2%. At the same time, the maximum extraction of croup-denser products -77.2% was obtained from sample No. 3 andthe minimum -66.9% from sample No. 11. The average weighted ash content of the samples under study lies in the range of 0.94-1.16%.

Analysis of the ash content of the intermediate products of the croup systems (I-III br.s.) made it possible to reveal some regularities. As the yield of intermediate

Table 8: Indicators of the flour quality of the test flour samples obtained at the MDR-202 mill

	Flour indicators				Gluten			
Sample No.	Humidity	Ash content	Falling number (sec)	Whiteness (cond. unitRZ-BPL)	Percentage	IDK	Protein (%)	Size of sieve overs no 43
1	15.1	0.80	100	46	20.1	104	13.5	8
2	15.2	0.81	115	48	21.3	105	14.4	6
3	15.1	0.75	148	53	22.5	102	14.7	7
4	15.3	0.76	102	51	21.6	104	10.2	6
5	15.2	0.78	112	49	-		11.5	10
6	14.9	0.79	96	48	-		13.0	9
7	15.0	0.75	130	52	21.4	103	13.5	12
8	14.8	0.80	86	46	22.1	105	13.4	10
9	15.3	0.81	102	47	-		10.8	11
10	15.4	0.85	85	45	15.2	109	12.8	12
11	14.8	0.86	87	49	16.1	108	12.9	10
12	15.0	0.90	87	45	19.4	109	13.4	10

Table 9: Granulometric composition by size (dispersion)

	Average size of flour particles (µm)								
	260	190	160	125	100	80	60	50	40
Sample No. 1	2	3	4	5	6	7	8	9	10
1	12.1	14.1	20.9	10.9	8.7	3.8	4.6	16.5	8.4
2	12.7	14.9	21.1	11.5	7.9	6.1	5.7	13.2	6.9
3	12.6	14.2	21.3	12.1	8.1	11.2	5.1	8.4	7.0
4	10.5	13.1	20.1	11.1	8.5	8.2	5.7	15.4	7.4
5	11.9	13.0	21.1	12.0	7.9	4.2	6.9	14.9	8.1
6	12.1	13.4	20.8	11.2	8.5	6.1	6.3	14.5	7.1
7	11.4	14.1	20.7	10.5	6.7	9.1	5.9	14.3	7.3
8	12.8	13.5	21.4	8.9	7.9	4.1	6.8	15.8	8.8
9	12.5	13.4	20.5	12.4	8.4	3.9	5.7	14.1	9.1
10	12.1	14.2	21.1	9.9	8.9	5.2	5.9	14.6	8.1
11	11.9	13.4	20.9	8.5	8.6	5.0	5.8	16.3	9.6
12	12.5	13.1	21.2	10.1	7.9	6.5	5.9	15.7	7.1

products increases, their ash content decreases. The lowest ash content is noted at 77.2 and 76.5 extracts and is 0.94 and 0.97 for samples 3 and 7, respectively.

On the basis of the laboratory tests, optimal grinding modes were determined for milling the triticale grain samples which were: for the I break system -35-40%, for the II break system -45-50%, for the III break system -35-40%.

The flour quality indicators of the tested flour samples obtained on the laboratory mill unit of MDR-202 are given in Table 8.

Ash content and whiteness characterize the ratio of the content of particles of endosperm and bran skin the anatomical constituents of the triticale grain. In the samples No. 3, 7 the whiteness value of the flour was 53 and 52 cond. units accordingly and corresponds to the flour sown. In turn, the ash content of the tested samples was in the range from 75-90%.

Sample No. 3 differed by the maximum value of FN-148 s. (Taza variety). The minimum for sample No. 10-85 s. (Balausa variety).

The largest content of gluten in flour at sample No.3 2-2.5% (Taza variety). In samples of the Orda variety. No.5 and 6 and Balausa No. 9, no gluten was washed.

One of the important components of flour is protein. Since, when mixing the dough proteins swell forming gluten, affecting the structure of the dough. The highest protein content was observed in sample No. 3-22.5% (Taza variety).

Table 9 shows the granulometric composition of the test flour samples (average flour particle size, im). Analysis of the granulometric composition of the triticale flour (Table 9), obtained as a result of grinding, showed that the flour is characterized by a particle size of 40-260 im that is non-uniform flour dispersion and whiteness index.

Hence, it should be noted that when processing triticale grain in flour for use in the production of certain types of flour confectionery products among other properties, it is necessary to take into account uniformity in dispersion and whiteness of flour. In the process of grinding and forming the quality of triticale flour from the central part of endosperm, grains isolated from the flow of pure grits by processing the flow of cereals on the sieve machines will give a real opportunity to obtain a special flour with specified properties.

CONCLUSION

As a result of studies of technological properties of triticale grain recommended for cultivation in the Southern regions of Kazakhstan, it was established that the samples of the Taza variety were characterized by good plumpness, medium vitreousness, medium leveling, high protein and starch content.

Correlation relations between individual indicators of physico-chemical and biochemical properties of triticale grain were studied.

As a result of the studies, the optimal modes of the process of cold conditioning of grain of experimental varieties for various groups of vitreousness of triticale grain, recommended for the organization and management of the technological process of preparation of triticale grain for grinding.

According to the results of the study, it can be concluded that the grain of the tested triticale samples has a high cereal-forming ability. At the same time, the yield of croup-denser products varied from 66.9-77.2%. The maximum extraction of croup-denser products was noted in the samples of the Taza variety.

Analysis of the granulometric composition of the triticale flour obtained as a result of grinding showed that the flour is characterized by a lack of uniformity in the dispersion of flour with an average particle size in the range of 40-260 im.

REFERENCES

Bystrov, N.E., I.N. Zhukova, V.M. Reganov and S.D. Chebotarev, 2017. Range and doppler ambiguity elimination in coherent radar using quasicontinuous signals. J. Mech. Eng. Res. Dev., 40: 37-46.

Gold, R., 1967. Optimal binary sequences for spread spectrum multiplexing (corresp.). IEEE. Trans. Inf. Theory, 13: 619-621.

Martin, B. and P. Sole, 2008. Pseudo-random sequences generated by cellular automata. Proceedings of the International Conference on Relations, Orders and Graphs: Interactions with Computer Science, May 12-17, 2008, Nouha Editions, Mahdia, Tunisie, pp: 401-410.

Ongarbayeva, N., K.K. Zhanabayeva and Z.K. Nurgozhina, 2016. Influence of fineness of grinding of triticale flour on physicochemical parameters of sugar cookies. Mech. Technol., 2: 82-85.

Pankratov, G.N., E.P. Meleshkina, R.K. Kandrokov and I.S. Vitol, 2016. Technological properties of new varieties of triticale flour. Bread Prod., 1: 60-60.

Singer, J., 1938. A theorem in finite projective geometry and some applications to number theory. Trans. Am. Math. Soc., 43: 377-385.

Vitol, I.S., E.P. Meleshkina, R.K. Kandrokov, I.A. Verezhnikova and G.P. Karpilenko, 2016. Biochemical characteristics of new varieties of triticale flour. Bread Prod., 2: 42-42.