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Processing of Winter Triticale Grain into Varietal Bakery Flour According to a Developed Technological Scheme Using Sieve and Grinding Systems

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ABSTRACT

Triticale is a relatively new agricultural crop in the Russian Federation, used for food and fodder purposes. The State Register of Breeding Achievements Approved for Use in Russia (2021) includes 90 varieties of winter triticale and 18 varieties of spring triticale. Studies have been carried out to determine the flour milling properties of winter triticale grain according to a developed technological scheme of processing using sitting and grinding systems. It has been established that grinding triticale grain into varietal bakery flour according to a developed technological scheme using salt and grinding systems gives a significant increase in the yield of low-ash tritical varietal baking flour. Processing of triticale grain into baking flour according to a developed technological scheme makes it possible to obtain from 72 to 79.6% of varietal tritical bakery flour, while the yield of tritical flour of the highest grade T-60 is from 54.8 to 72.1%, which indicates the high efficiency of the developed developed technological scheme and good flour milling properties of the original samples. It has been established that the cumulative ash content curve of tritical flour according to a developed technological scheme of processing can be represented in the form of two, rather than three linear sites as in processing according to the abbreviated technological scheme. It was revealed that the grain of triticale of the Alexander variety was inferior in its flour-milling properties to the Valentin and Aquarius varieties, which is due to the low groat-forming ability of this variety.

Introduction

Triticale is a relatively new agricultural crop in the Russian Federation, used for food and fodder purposes. The State Register of Breeding Achievements Approved for Use in Russia (2021) includes 90 varieties of winter triticale and 18 varieties of spring triticale. For comparison, in 2010, 45 varieties of winter triticale and 3 varieties of spring triticale were introduced. It should be noted that all new varieties are recommended to be used for food purposes. Currently, in the Russian Federation, about 90% of triticale grain is used as a grain component of compound feed and about 9% for the production of alcohol. It is promising to use tritical flour as a raw material, instead of wheat baking flour, in the production of flour confectionery products: cookies, biscuits, cakes, waffles, muffins, crackers, etc. Tritical flour can be used in the production of noodles that do not require cooking, quick breakfasts or for the manufacture

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of dietary and therapeutic and prophylactic varieties of bread, including whole grain and multigrain [1-6]. Studies of foreign scientists conducted in recent years are mainly related to the biology of triticale species and biosafety in its growth and development, the origin of hexaploid triticale, industrial production of triticale and its competitiveness with wheat, genomics and biotechnology of triticale grain and products of its processing. [7-13]. There are very few works devoted to the technology of processing triticale grain into varietal bakery flour. The purpose of our research is to develop a developed technological scheme for processing triticale grain into varietal bakery flour using salt and grinding systems.

Objects and Methods of Research

In experimental studies conducted at the Department of Grain, Bakery and Confectionery Technologies, samples of winter triticale grain of 3 varieties Alexander, Valentin and Aquarius, bred by breeders of the RSAU-MOSCOW Agricultural Academy named after K.A. Timiryazev, were used. Development of the technology of grinding triticale grain into varietal bakery flour according to a developed technological scheme was carried out using the presented varieties of triticale grain. These samples were distinguished by significant differences in ash content, vitreousness, mass of 1000 grains, etc. Indicators of the quality of samples of triticale grain of different varieties are presented in (Table 1). Preparation of triticale grain for grinding was carried out according to the previously established parameters of hydrothermal treatment [1]. Grinding of the original triticale grain was carried out at laboratory grinding mills MLP-4 with rifled rollers and micro-rough rollers. Enrichment of grinding intermediates was carried out on a laboratory sieve machine. The set of sieves and the air flow rate of the sieve machine were selected depending on the size of the intermediate products of grinding the triticale grain entering for enrichment. Sieving of grinding products was carried out in laboratory sieving for 90 seconds. The parameters and modes of grinding corresponded to the recommended “Rules for the organization and conduct of the technological process at flour mills” for varietal grinding of soft wheat.

Results and their Discussion

At the first stage of research to determine the composition of intermediate cereal grinding products of triticale grain grinding, studies of the process of enrichment of cereals on sieve machines based on modeling of industrial processes of varietal grinding with a developed technological scheme were carried out. In the process of laboratory grinding, a significant content of intermediate grinding products in the form of high-quality cereals was noted. In this regard, experimental grinding was carried out in order to determine the feasibility of enriching the cereals. The grouping of flows by endosperm content of intermediates provided for 3 classes: the first class is grains consisting of endosperm particles; the second class is intergrowths, that is, particles consisting mainly of the endosperm and a small inclusion of the membranes; the third class is a similar particle, mainly consisting of shells. Evaluation by classes of intermediate products of triticale grain grinding was carried out visually. The determination of the number of particles of different classes was carried out as follows. A mixture of particles of a certain class was evenly distributed in one layer on a flat, well-lit white surface. Particles were counted on an area of 1 cm^2 (a platform of 1×1 cm), using a textile magnifying glass of 7x. The number of samples formed in this way was at least 7. Determination of the required volume of measurements was carried out on the basis of statistical analysis.The number of particles in the sample varied over a wide range: for the 560/900 μm fraction, the number of particles from 15 to 55 pieces, for the fractions 355/560 μm and 250/355 μm, the number of particles in the sample is from 35 to 150 pieces. Statistical analysis showed the independence of the content of cereals from the sample size. The correlation coefficient was less than 20%. Experimental data show that the stabilization of the concentration of cereals is achieved with a total number of particles of more than 700.

Visual inspection of the fractions of intermediate products showed that, regardless of the grain grade, a large grain of 560/900 μm obtained on the II dranoy system and the average grain of 355/560 μm obtained on the III dranaya system contain a significant number of endosperm particles. This is confirmed by the ash content of these fractions. The ash content of the fraction 900/560 III of the draught system varied from 1.29 to 1.64%; ash content of fraction 560/355 III of the draught system from 1.15 to 1.31%. It is known that the enrichment of cereals in sieve machines makes sense when the concentration of “pure” grains is more than 50%. For this reason, a preliminary analysis of the composition of the fraction 560/900 II of the dranaya system and 355/560 III of the draught system was carried out and the concentrations of cereals, sprouts and similar products were determined. The result of this analysis is presented below. The weighted average value (median) of the composition of the fraction of intermediate products of grinding triticale grain in the range of 560/900, obtained on the II dranaya system was: cereals - 58.7%; sprouts – 28.0%; similar product – 13.3%. The weighted average value (median) of the composition of the fraction of intermediate products of triticale grain grinding in the range of 355/560, obtained on the III draught system was: cereals - 62.0%; sprouts – 40.4%; similar product – 7.6%. Thus, the obtained fractions of intermediate products of grinding triticale grain with a size of 560/900 with a size of the II stripe system and a size of 355/560 with a size of 355/560 with the III of the drana system should be sent for enrichment in sieve machines. During subsequent grinding, the sediments of the sithing

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machine of these fractions were combined with similar products of the corresponding systems. At the second stage of research, a developed technological scheme for grinding triticale grain into baking varietal flour was developed, including 4 draught, 6 grinding, 2 grinding and 3 sieve systems. As a result of laboratory grinding of the presented samples of triticale grain, 12 streams of flour and 2 streams of bran were obtained.

Yields and qualitative indicators of the obtained individual streams of tritical flour from triticale grain of the "Alexander" grade from all technological systems are presented in (Table 1). As can be seen from (Table 2), when processed according to a developed technological scheme, the total yield of tritical flour from the Alexander variety was 72.0% and 28.0% of tritical bran, while the yield of the best tritical flour T-60 was 54.8%. The yield and qualitative indicators of the obtained individual streams of triticale flour from the grain of triticale grade "Valentin" from all technological systems are presented in (Table 2). As can be seen from (Table 3), the total yield of tritical flour from the Valentin variety was 79.6% and 20.4% of tritical bran when processed according to a developed technological scheme, while the yield of the best tritical flour T-60 was 56.1%. Yields and qualitative indicators of the obtained individual streams of tritical flour from the grain of triticale grade "Aquarius" from all technological systems are presented in (Table 4). As can be seen from (Table 3), the total yield of tritical flour from the "Aquarius" variety was 79.4% and 20.6% of tritical bran when processed according to a developed technological scheme, while the yield of the best tritical flour T-60 was 72.1%. Based on the results of the obtained qualitative indicators of tritical flour flows, cumulative ash curves were constructed. Comparing the results of grinding different varieties of triticale according to the developed scheme and grinding according to the abbreviated scheme, it is possible to note their significant difference [3]. First, the amount of low-ash flour increased significantly with the developed scheme. Secondly, the cumulative ash content curve of the grinding flour according to the developed scheme can be represented in the form of two, rather than three linear plots. This was fully confirmed by statistical analysis. According to the results of laboratory grinding according to the developed technological scheme of triticale grain, it was established that the Alexander variety was inferior in its flour milling properties to other varieties, which is due to the low grain-forming ability.

Table 1: Quality indicators of triticale grain samples of different varieties.

Triticale variety	Weight 1000	Triticale variety	Weight 1000	Triticale variety	Weight 1000
Alexander	41,7	40	736	1,87	11,2
Valentine	47,7	55	752	1,98	11,6
Aquarius	49,2	62	781	1,76	11,8

Table 2: Indicators of the yield and quality of flour from triticale grains of the "Alexander" variety.

Name product	Thread number	Output, %	Whiteness, units etc., R3-BPL	Ash content, %	Increasing output, %	Whole ash %
Flour 1 grinding system	7	14,0	58,5	0,53	14,0	0,53
Flour 1 grinding system	5	3,5	60,5	0,55	17,5	0,53
Flour 2 grinding system	6	2,7	53,3	0,55	20,2	0,54
Flour 2 grinding system	8	7,6	51,0	0,57	27,8	0,55
Flour II frayed system	2	9,5	59,6	0,64	37,3	0,57
Flour III frayed system	3	6,1	47,5	0,67	43,4	0,58
Flour 3 grinding system	9	4,7	43,5	0,70	48,1	0,59
Flour I frayed system	1	6,7	51,0	0,75	54,8	0,61
Flour IV frayed system	4	3,4	30,0	1,20	58,2	0,65
Flour 4 grinding system	10	8,2	27,3	1,26	66,4	0,72
Flour 5 grinding system	11	3,4	10,3	1,53	69,8	0,76
Flour 6 grinding system	12	2,2	-2,5	1,76	72,0	0,79
Total flour:		72,0				0,79

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Table 3: Yield and quality indicators of flour from triticale grains of the "Valentin" variety.

Name	Flow number Yield, % Whiteness, units etc.	Flow number Yield, % Whiteness, units etc.	Flow number Yield, % Whiteness, units etc.	Flow number Yield, % Whiteness, units etc.	Flow number Yield, % Whiteness, units etc.	Flow number Yield, % Whiteness, units etc.
product	5	9,1	67,6	0,47	9,1	0,47
Flour 1 grinding system	6	4,1	56,9	0,52	13,2	0,49
Flour 2 grinding system	7	19,0	59,3	0,57	32,2	0,54
Flour 1 grinding system	8	9,4	50,7	0,64	41,6	0,56
Flour 2 grinding system	9	4,7	42,5	0,75	46,3	0,58
Flour 3 grinding system	1	9,8	47,7	0,83	56,1	0,62
Flour I frayed system	2	7,2	46,4	0,83	63,3	0,65
Flour II frayed system	3	3,3	36,0	1,13	66,6	0,67
Flour III frayed system	10	6,1	17,3	1,51	72,7	0,74
Flour 4 grinding system	4	2,2	20,5	1,89	74,9	0,77
Flour IV frayed system	11	3,0	-8,8	2,01	77,9	0,82
Flour 5 grinding system	12	1,7	-24,0	2,52	79,6	0,86
Flour 6 grinding system		79,6				0,86

Table 4: Indicators of the yield and quality of flour from triticale grains of the "Aquarius" variety.

Name	Thread number	Thread number	Thread number	Thread number	Thread number	Thread number
product	5	9,8	69,8	0,38	9,8	0,38
Flour 1 grinding system	7	19,3	62,6	0,46	29,1	0,43
Flour 1 grinding system	6	4,6	59,5	0,47	33,7	0,44
Flour 2 grinding system	9	6,3	43,5	0,53	40,0	0,45
Flour 3 grinding system	8	7,2	54,5	0,56	47,2	0,47
Flour 2 grinding system	2	4,5	48,1	0,68	51,7	0,49
Flour II frayed system	1	9,9	51,3	0,71	61,6	0,52
Flour I frayed system	3	3,0	35,6	0,96	64,6	0,54
Flour III frayed system	10	7,5	20,8	1,30	72,1	0,62
Flour 4 grinding system	4	2,0	22,3	1,59	74,1	0,65
Flour IV frayed system	11	3,5	-3,4	1,80	77,6	0,70
Flour 5 grinding system	12	1,8	-21,5	2,23	79,4	0,73
Flour 6 grinding system		79,4				0,73

At the final stage of research for a comparative analysis of the processing of triticale grain into baking flour according to a developed technological scheme, the formation of tritical flour flows was carried out, which included 3 stages (indices A, B, C). The first stage corresponded to the yield of flour up to 40%, the second - up to 70%, and the third - more than 70%. The high-confidence approximation equations ($R2 > 90\%$) are presented below. Tritical flour flows A + B are formed by flour flows from 1 grinding system + 2 grinding system + 1 grinding system + 2 grinding system + I strip system + II strip system + III strip system + 3 grinding system. Total output/ash content 57.9/0.66. $ZA = 0.462 + 0.319\times10\text{-}2\ IA$; $R2=0{,}97$. Tritical flour flow B is formed by flour flows from the IV stripe system + 4 grinding systems + 5 grinding systems + 6 grinding system. Total output/ash content: 17,6/1,43; $ZB = 0.086 + 0.990\times10\text{-}2\ IW$; $R2=0{,}99$.

Findings

1. Grinding triticale grain into varietal bakery flour according to a developed technological scheme using salt and grinding systems gives a significant increase in the yield of low ash tritical varietal baking flour.
2. Processing of triticale grain into bakery flour according to a developed technological scheme makes it possible to obtain from 72 to 79.6% of varietal tritical bakery flour, while the yield

of tritical flour of the highest grade T-60 is from 54.8 to 72.1%, which indicates the high efficiency of the developed developed technological scheme and good flour milling properties of the initial samples.

3. The cumulative ash content curve of tritical flour according to a developed technological scheme with the use of grinding and sieve processing systems can be represented in the form of two, rather than three linear sections as in processing according to the abbreviated technological scheme.

4. It was revealed that the grain of triticale of the Alexander variety was inferior in its flour-milling properties to the Valentin and Aquarius varieties, which is due to the low grain-forming ability of this variety.

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