International Journal of Biotechnology and Food Science
Vol. 2(6), pp. 112-115, September 2014
ISSN: 2384-7344
Research Paper

Correlation of micro sodium dodecyl sulfate sedimentation test and bread making quality traits in hexaploid triticale (X *Triticosecale* Wittmack)

Djatchouk TI* • Kibkalo IA • Pominov AV • Italianskaya YUV • Safronova NF

Department of Biotechnology, Agricultural Research Institute for South-East Region of Russia, Toulaikova, 7, Saratov, Russia.

*Corresponding author. E-mail: cell-selection@list.ru. Tel: 8-927-107-59-49. Fax: 8(845)2647688.

Accepted 30th August 2014

Abstract. The results of studies of micro SDS-sedimentation value in VIR-collection samples and ARISER advanced lines of winter hexaploid triticale in arid Volga-region of Russia are given in the article. The collection samples and advanced lines with SDS-sedimentation-value 40 to 50 mm and more were revealed. Statistically a highly significant correlations were detected between sedimentation value and several quality parameters such as units of gluten deformation index (r = -0.71**), valorimetric evaluation (r = 0.62**), time of dough formation (r = 0.64**), dough liquefaction (r = -0.45*) and bread porosity (r = 0.69**). The promising lines with better bread making quality were advanced.

Keywords: Triticale, bread making quality, SDS-sedimentation test, correlation.

Abbreviations: ARISER, Agricultural Research Institute for South-East Region of Russia; **BV,** bread volume (sm3 /100 g of flour); **DL,** dough liquefaction (units of farinograph); **DTD,** dough time development (min); **FN,** falling number (s); **FAC,** Fischer's actual criterion; **GLU,** gluten content (%); **IDG,** index deformation of gluten (units of IDG); **POR,** porosity (balls); **PRO,** protein content (%); **SDS,** sodium dodecyl sulfate sedimentation volume (ml); **VAL,** valorimetry (units of valorimeter); **VIR,** N.I Vavilov Research Institute of Plant Production; **WAB,** water absorption (%).

INTRODUCTION

Triticale (X Triticosecale Wittmack), the first man-made cereal, has a large productivity potential and higher adaptive properties as compared to wheat (Grabovets et al., 2013). Triticale is produced mainly for animal feed and forage. However, the crops may have the same potential for bread making as wheat, because of high concentrations of essential amino acids in grain that makes it more nutritionally valuable than wheat (Mossė et al., 1988). Economical advantage also is evident. Developed in different countries triticale cultivars are able to give a stable yield, which is 20 to 35% higher in compare to wheat under unfavorable conditions (Shipak et al., 2013).

If triticale is to become a bread cereal, its technological traits must be comparable or equal to that of bread wheat. Good quality of baked products can be obtained from triticale by using different baking technologies (Karchevskaya et al., 2014). On the other hand, it is important to develop triticale varieties for baking purposes. Bread making quality of bread wheat is determined by several factors of which the quantity and quality of forming storage proteins are critical. Glutenin is the major protein determining dough characteristics (Graybosch et al., 1996). Gluten–forming proteins are encoded by loci located on chromosomes of groups 1 and 6 (Pane et al., 1984). The low rheological indexes of hexaploid triticale dough are linked to the absence of the D-genome (1D chromosome) and to a negative effect of rye secalins (Sec-1) (Kumlay et al., 2003). Thus the improvement of triticale baking quality may be achieved with chromosomal engineering transferring 1D chromosome of a bread wheat or their segments (*Glu-*

Table 1. SDS-sediment volume in VIR-collection samples of hexaploid triticale (2012 to 2013).

Group	SDS-sediment volume (ml)	VIR-collection samples
I	22-35	Student (к-2899), Svyatosar (к-3940), Sargau (к-3599), Yubileynaya (к-3941), AD 412/2 (к-3620), Mihas (к-3689), Colina (к-3458), Strelets (к-3581), Hongor (к-3765), Kornet (к-3636), Agraf (к-3609), Tarasovskiy Yubileyniy (к-3635), Antey (к-3562), Nemchinovskiy 56 (к-3861), Alemo (к-3598), ADM-11 (к-3629), Altaiskaya 5 (к-3639).
II	36-50	Mudrez (к-3762), Runo (к-3691), Dubrava (к-3686), Kastus (к-3757), Alamo (к-3598), Souz (к-3580), Mir (i-0138505), Rus (i-0138506), AD Zeleniy (к-564), Don (к-3637), Vodoley (к-3600), AD 7696 (к-3619, NAD 325 (к-136), NAD 432 (к-140), KS 88T 142 (к-3442), Pinokio (к-3597), Maslovskiy (-), ADM- 9 (к-3421), Polesskiy 7 (к-3594), ADM-7 (к-3420), Flamingo (к-3548), Polesski 10 (к-3610), Suvenir (к-3595), Zakarpatskaya mnogozernaya (к-3418), Altayskaya 4 (k-3638), Modus (к-3507).
III	51-60	Valentin 90 (к-3761), Region (к-3694), ADP-2 (к-3628), Line 14 (к-3643), Razgar (к-3642)
IV	>70	Ellada (к-3596),

D1d allele encoding HMW-GS 5+10) (Lukaszevski, 2006). On the other hand, there is the opinion that for achievement of this purpose it is important to develop genotypes with a stable protein content (12.5 to 14% and more), raw gluten (up to 20%) not below group II by quality, falling number 150s and more regardless the R/D–chromosomes substitutions (Grabovets et al., 2013).

The development of new triticale cultivars for bread baking purpose requires the evaluation of parents and breeding lines. The small-scale quality tests are needed that significantly correlates with well known bread baking characteristics. The aim of this study was investigation of the SDS-sedimentation value in the N.I. Vavilov Research Institute of Plant Production samples (VIR-collection) and of its correlation with the other grain quality parameters in advanced lines of winter hexaploid triticale developed in Agricultural Research Institute for South-East Region of Russia (ARISER).

METHODOLOGY

VIR-collection was presented by 49 samples. They were planted in two-row plots in 2012, 2013 that were 1.2 m long with 20 cm between rows. The advanced ARISER lines were planted in a randomized complete block design with two replications in 2012, 2013.

The protein content was determined by Kjeldahl method (Vasilenko and Komarov, 1987). Gluten elasticity was evaluates in units of apparatus IDG in which gluten is subjected to influence of deformation by load. The classification in to quality groups was made according State Standard of Russian Federation 13586.1-68. Falling number was measured by apparatus Falling Number (Hagberg-Pertens method). Physical characteristics of dough (water absorption, dough time development, dough liquefaction) were determined by means of farinograph (Brabender) according to instruction. The value of area occupied by farinogramme served as united general index that was determined by special mechanism – valorimeter. Bebyakin *et al.* (1987) micro SDS method was used for determination of the SDS-sediment volume.

For loaf baking procedure 100g of flour was used. A dough process with fermentation time between 3 and 4 h was used with intensive dough mixing (Vasilenko and Komarov, 1987). The bread porosity was determined visually.

Statistical analysis

Data were analyzed with using of the AGROS-2.10 program.

RESULTS AND DISCUSSION

SDS-sediment volume varied from 22 to 79 ml in VIR collection samples. The samples were divided in to four groups depending on SDS volume (LSD_{05}-14 ml). The first group included the samples with sediment volume of 22 to 35 ml. The second group was formed from the samples with sediment volume of 36 to 50 ml. Third group with sediment volume of 51 to 60 ml contained only five samples (Valentin 90 (к-3761), Region (к-3694), ADP-2 (к-3628), Line 14 (к-3643), Razgar (к-3642). The variety Ellada (k-3596) had the greatest SDS-sediment (79 ml) among the samples of VIR-collection triticale appropriate to soft wheat (71 to 97 ml) (table 1).

SDS sediment in advanced ARISER triticale lines varied from 25 to 54 ml. The gluten quality that was determined as gluten deformation index fluctuate from 66 to 92 unit of IDG. The lines developed had different quality

Table 2. SDS value and Bread making quality grain parameters in ARISER advanced lines of triticale.

No. lines	PRO	GLU	IDG	FN	SDS	DTD	DL	VAL	BV	POR
1-11	17.6	31.0	92	270	25	1.8	210	26	530	3.8
2-11	13.1	29.2	85	181	29	1.2	230	21	540	3.6
3-11	12.5	22.4	72	101	32	2.8	170	34	520	3.8
4-11	14.0	32.0	89	63	28	1.2	255	18	510	4.4
5-11	12.3	27.5	79	219	37	3.0	210	36	540	4.5
6-11	12.8	28.6	71	179	33	2.0	180	37	580	4.2
6a-11	13.0	25.0	77	259	41	2.8	160	36	460	3.8
8-11	12.7	32.0	86	181	30	2.0	240	27	450	4.2
9-11	12.7	24.0	66	176	54	3.5	190	40	550	5.0
10-11	13.0	25.0	81	132	34	2.0	220	27	500	4.8
13-11	13.7	32.0	82	80	34	1.5	220	22	550	4.0
14-11	12.5	25.0	76	222	44	2.5	160	34	640	5.0
15-11	13.3	22.5	78	89	32	2.2	220	28	500	3.8
16-11	13.3	26.0	78	283	28	2.0	210	29	450	4.0
17-11	12.0	26.0	75	173	37	3.0	150	38	460	4.0
18-11	11.5	23.0	76	115	37	3.0	180	36	530	4.6
19-11	12.1	25.0	87	98	27	2.0	190	26	600	4.0
20-11	12.6	30.0	87	75	29	1.8	260	23	480	3.6
21-11	12.6	29.2	77	310	33	2.0	200	28	510	3.8
22-11	11.6	23.0	72	67	34	2.0	230	28	530	4.0
23-11	13.0	25.0	85	85	40	1.8	210	26	480	4.0
24-11	12.6	29.7	82	238	38	1.8	250	22	530	4.8
26-11	12.2	26.0	68	205	43	2.8	170	36	550	5.0
27-11	12.5	26.8	70	366	-	-	-	-	580	5.0
mean	12.9	26.7	78.8	175.1	34.9	2.2	205.0	29.6	523.5	3.5
cv	4.7	11.5	8.8	49.1	18.8	27.8	19.8	21.5	8.6	11.3
FAC	9.6*	26.3*	10.3*	92.7*	18.2*	15.6*	7.1*	20.7*	6.4*	12.7*
LSD_{05}	1.1	1.8	6.5	26.2	4.5	0.5	34.7	4.1	52.1	0.8

* - values are significantly different at the 0.05 probability level.

Table 3. Correlation matrix of SDS and bread making quality parameters of advanced triticale lines.

	FN	PRO	GLU	IDG	WAB	DTD	DL	VAL	BV	POR	SDS
FN	1.0										
PRO	-0.23	1.0									
GLU	-0.02	0.55**	1.0								
IDG	-0.25	0.46*	0.53**	1.0							
WAB	-0.23	0.21	0.36	0.46*	1.0						
DTD	0.23	-0.43*	-0.50*	-0.78**	-0.68**	1.0					
LIQ	-0.31	0.31	0.53**	0.62**	0.75**	-0.75**	1.0				
VAL	0.31	-0.42*	-0.52*	-0.79**	-0.70**	0.98**	-0.83**	1.0			
BV	0.06	-0.10	-0.08	-0.21	-0.25	0.09	-0.19	0.08	1.0		
POR	0.28	-0.26	-0.04	-0.44*	-0.19	0.39	-0.20	0.35	0.44*	1.0	
SDS	0.30	-0.27	-0.35	-0.71**	-0.30	0.64	-0.45*	0.62**	0.25	0.69**	1.0

* and ** indicate significant at the 0.05 and 0.001 probability level, respectively.

groups. The lines with group Ⅰ of quality (45 to 75 units of IDG) were detected (6-11, 3-11, 17-11 and 27-11) (table 2).

The falling number method is used for evaluation of alpha-amylase activity. It reflects the state of carbohydrate-amylase complex. The higher activity of α- amylase the quicker would starch breakdown and the lower would falling number. Falling number varied in lines developed in wide range (67-366s). The line No. 27 (F7 Newton/Sargau//KS88T142) had the inferior falling number (366s).

Protein content of advanced lines varied from 11.5 to 17.6%. Gluten content was 23.0 to 32.0%. High protein content not necessarily indicates high gluten content and high gluten does not necessarily indicate high quality parameters. Line No. 1 to 11 had the higher protein content (17.6%) however IDG was 92 units and SDS volume was lowest. Lines No. 8 to 11 and No. 9 to 11 had the same protein content but gluten content and gluten quality were different. Baking characteristics were different also.

Significant differences were observed for all end-use quality traits among the advanced lines. The test baking results showed the promising bread making potential for lines No. 9 to 11, No. 14 to 11 and No. 26 to 11. The volumetric yield of the bread of these lines came to 550 to 640 sm^3/100 g of flour. The amount of raw gluten varied from 24 to 26%, IDG was 66 to 76 units of the device, falling number was 176 to 222s, SDS-sediment volume – 43 to 54 ml and valorimetry – 43 to 54 units.

Statistically highly significant correlations were revealed between sediment value and gluten deformation index (r = -0.71**), valorimetric evaluation (r = 0.62**), time of dough formation (r = 0.64**), dough liquefaction (r = -0.45*) and bread porosity (r = 0.69**). The correlation between SDS-volume and protein content was not found (table 3).

CONCLUSION

The set of VIR Collection samples is characterised by broad SDS-sedimentation Volume ranges. The samples were selected which can serve as initial breeding stock for triticale bread making potential.

The advanced triticale lines were selected with improved baking characteristics.

Thus SDS test can provide useful supplemental information in classifying of breeding triticale lines in broad quality ranges.

ACKNOWLEDGEMENT

We wish to thank the ARISER lab of grain quality for collaboration.

REFERENCES

Bebyakin VM, Buntina MV, Vasilchuk NS (1987). Significance of SDS-sedimentation index in connection with durum wheat breeding. J. Russ. Agric. Sci. 3:3-5.

Grabovets AI, Krokhmal AV, Dremucheva GF, Karchevskaya OE (2013). Breeding of Triticale for baking purposes. Russ. Agric. Sci. 2:3-8.

Graybosch RA, Peterson CJ, Shelton DR, Baenziger PS (1996). Genotype and environmental modification of wheat flour protein composition in relation to end-use quality. Crop Sci. 36:296-300.

Karchevskaya OE, Dremucheva CF, Smirnova GA (2014). Using food processing for triticale of extrusion and bakery products a higher nutrional value. in: Proc. Int. Triticale Conf."The role of triticale in stabilizing grain production, feed and technologies". Russia, 4-5 June, 2014, Rostov-on-Don. pp. 168-172.

Kumlay AM, Baenziger PS, Gill KS, Shelton DR, Graybosch RA, Lukaszevwski AJ, Weswnberg DM (2003). Understanding the effect of rye chromatin in bread wheat. Crop Sci. 43:1643-1651.

Lukaszevski A (2006). Cytogenetic engineered rye chromosomes 1R to improve bread-making quality of hexaploid triticale. Crop Sci. 46:2183-2194.

Mosse J, Huet JC, Baudet J (1988). The amino acid composition of triticale grain as a function of nitrogen content; comparison with wheat and rye. J. Cereal Sci. 7:49-60.

Pane PI, Lawrence GJ (1987). Genetics of wheat storage proteins and the effect of allelic variation on bread making quality. Ann. Rev. Plant Physiol. 38:141-153.

Vasilenko II, Komarov VI (1987). Value of grain quality: reference book. M., Agropromizdat. p. 208.

Shipak GV, Tsupko YuV, Shipak VG (2013). Bread-making qualities of the cultivars of winter hexaploid Triticale. Russ. Agric. Sci. 1:3-8.