

EFFECT OF SHORT TERM STORAGE ON WHEAT QUALITY PARAMETERS

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ABSTRACT

Eleven samples of registered wheat varieties of bread with diverse technological qualities were used in this study. The samples were divided into two groups. The first group including all the 11 variety were stored for 3 months, while the second group of the samples were stored for 9 months at an ambient temperature. The results of quality evaluation showed that 5 soft wheat varieties (GK Csongrád, GK Garaboly, GK Hattyú, GK Holló, GK Nap) and 6 hard wheat varieties (GK Ati, GK Békés, GK Élet, GK Kalász, GK Petúr, GK Verecke) were involved in the study. Further, the flour yield, the gluten index and the water absorbance capacity has significantly decreased after 9 months storage time when compared to 3 months storage interval.

Keywords: wheat quality, Hungarian wheat varieties, short term storage

1. INTRODUCTION

The wheat is the most valuable cereal. It is grown in 240-250 m acre all over the world [1], [2]. Cereal grains and wheat in particular, are among the most important crops globally [3]. The quality of wheat is of primary importance, since it determines the excellence of the products processed from it. The different consumption habits do require diverse quality, and thus the quality behaviour must be permanent. To maintain this permanency in biological system is far too difficult, since different conditions, i.e. the agricultural land use, the weather, etc. have all significant role in variance of quality factors. Körmöczi et al. genetically analysed the wheat species, to improve further the crop quality and quantity [4]. Very important parameter of wheat kernel is the hardness of the kernel. It determines the consumption and the parameters of the technology especially that the hardness of the kernel changes as a result of debranning [5]. In Hungary wheat is usually not processed after harvesting, but it is stored for short term. Storage in this sense is of primary importance, since its aim is to keep the quality of the cereals.

There is a requirement to ensure the organoleptic quality of crops to ensure good commercial returns and safety of the product [6]. Wheat produces different volatiles with changing storage time. Grain quality maintenance has traditionally been the responsibility of grain storekeepers who rely on measurements of grain or its milled products and on implicit knowledge gained through scientific results, common sense and job experience. The wheat grist is changing during the storage [7]. The quality of the grain is significantly affected by the kernel hardness already mentioned. In this way, wheat varieties can be classified into several groups [8]. It has a good adaptability, and it has a lot of variety, and the demand of these varieties is widespread. The consumer demand is high for cereals, since it is widely used in different food industry sectors such as the confectionary or the baking industry. The wheat flour is an excellent base for bakery products and offers many new developments (for example: fiber-enriched products) [9]. The wheat is good feedstock also, and these secondary products have high value, due to the fact that wheat bran contains significant amount of protein, the wheat bran contains a lot of protein. The straw is a good litter. [10], [11].

The storage of the cereals is a very complex task, because in this early stage it is an active material, it has not reached the full ripening stage, but it can be infected by microorganisms, by insects or murine infection if not properly handled. To maintain grain quality during storage, grain must be protected from the growth and reproduction of insects, mites and fungi [12], [13]. Young larvae of this species frequently feed on the germ of whole kernels and on fine material in the grain [14]. So to the professional storage, we have to know the biology, biochemical changes that may occur, and a state-of-art technology [15]. The tendency of the last time is to increase the size of the silos intended for storage of the wheat. Lukow and White [16] studied the changes of the milling and baking parameters of wheat produced in the USA. The storage of the wheat was also studied by Wilcke et al [17] during a 15 months time interval at temperatures in the range of -4°C and 25°C , and air humidity in the range of 28% and 73%.

The wheat after the harvest is live; the manifestation of it is the organic content biochemical transformation. It depends of the moisture, the temperature, the health of the wheat, etc. The biochemical transformation causes some end-product. The enzyme activity causes the fermentation, alcohol and organic acid formation.

- Criterion of wheat quality:
- Problem of the storage and processing, depend on the raw material, economic process
- The end-product reference specific

The quality of the end-product, the appearance of the product, satisfy the consumer demand (generally and specifically)

Hrušková and Machová [18] examined the sort term storage and its effect to the flour quality. The changes in the moisture contents depended on the short time storage conditions and had a different time course in the individual locations. Wet gluten content tended to decrease with time but the differences did not seem to be significant for the flour quality.

The first aim of the storage is to keep the quality of the wheat [19], [20]. If the storage is safe, the wheat quality will be well maintained e.g. physical, chemical state, technological behaviours, nutritive, hygiene [21]. The quality of the wheat is determined by external and the internal component of the kernel. The internal component is the protein, starch, lipid, cellulose, minerals, etc. content. The dough properties also depend on the hardness of the wheat as published by Szabo [22]. The environmental effects determine the cultural plant quality, although the composition of wheat is determined by a genetic factor.

2. MATERIALS AND METHODS

In this study our aim was to investigate the short term storage on the wheat quality including 11 varieties.

2.1. Materials

Eleven different registered wheat varieties of bread with diverse technological qualities were used in this study. The samples were provided by the Cereal Research NPC, Szeged, in Hungary, and included the following varieties:

- GK Garaboly
- GK Békés
- GK Kalász
- GK Verecke
- GK Holló
- GK Ati
- GK Petur
- GK Nap
- GK Élet
- GK Csongrád
- GK Hattyú

The samples were harvested in two different seasons (Bem. 2. and Bem. 3.). The weather parameters was different in the harvest time. The samples of the 11 varieties were divided into two parts, the first part was stored for 3 months and examined afterwards (autumn research). The second part was stored for 9 months. The temperature of storage in both case was an ambient temperature.

2.2. Methods

Hardness index: Wast to test using Perten SKCS 4100 (Perten Instruments, Springfield, Illinois, USA). This machine reports the average force for crushing 300 kernels, in terms of a hardness index (HI).

Milling test: Brabender ® Quadrumat ® Senior (Brabender GmbH & Co. KG, Duisburg, Germany) laboratory mill was used to determine the milling properties and the flour yield of the different types of wheat.

Ash content: According to AACC methods using OH63 (Labor-MIM Budapest, Hungary) equipment

Ash content refers to the mineral content of flour. It depends on many factors, such as the variety of wheat, the fertilization, the climate, etc.

Gluten index: The gluten index (GI) was examined by Glutomatic 2200 (Perten Instruments AB Huddinge, Sweden) Dry gluten content was measured after drying with Glutork 2020 (Perten Instruments AB Huddinge, Sweden) automatic gluten dryer.

Farinograph test: The farinograph determines dough and gluten properties of a flour sample by measuring the resistance of dough against the mixing action of blades. Absorption is the amount of water required to center the farinograph curve on the 500-Brabender unit line. We used the Brabender ® farinograph (Brabender GmbH & Co. KG, Duisburg, Germany)

Alveograph characteristics: Chopin Alveograph NG (CHOPIN Technologies, Villeneuve-la-Garenne Cedex, France) the alveograph test were determined according to the EU-Standards. The alveograph determines the gluten strength of dough. It is measuring the force required to blow and break a bubble of dough. The results include P Value, L Value, P/L Value and W Value.

Statistical analysis-Statistica 8.0 (StatSoft, Inc. Tulsa, USA) and Microsoft © Office 2003 Excel software for Windows were used to perform statistical analyses. The samples were tested for significance using analysis of variance techniques (ANOVA). Three effects were investigated; varieties, harvesting time (Bem 2. and Bem 3.) and storage effect (Autumn search and Spring search). A level of significance of $p < 0.05$ is used throughout the analysis.

3. RESULTS AND DISCUSSION

The physical, physicochemical and baking characteristics of the 11 varieties in spring and autumn research have been evaluated. Table 1 shows the results of the kernel parameters, Hardness Index and other technological traits of the wheat samples.

Table 1. Selected technology parameters of the entries in the study

Harvest time	Variety		Width	Lenght	Depth	Thousand kernel weight	Hectolitre weight	SKCS HI
Bem.2.	GK ATI	Autumn search	3,11	5,81	2,85	39,70	78,77	78,68
Bem.2.	GK BÉKÉS	Autumn search	3,21	6,48	2,83	37,45	75,62	75,29
Bem.2.	GK CSONGRÁD	Autumn search	3,10	6,03	2,87	43,39	75,80	49,54
Bem.2.	GK ÉLET	Autumn search	3,38	6,60	2,96	40,55	77,93	71,57
Bem.2.	GK GARABOLY	Autumn search	3,29	6,34	2,90	37,93	78,97	49,15
Bem.2.	GK HATTYÚ	Autumn search	3,52	6,40	2,88	44,70	77,43	32,56
Bem.2.	GK HOLLÓ	Autumn search	3,19	6,03	2,70	37,70	77,42	44,29
Bem.2.	GK KALÁSZ	Autumn search	3,39	6,56	2,83	41,99	76,77	70,21
Bem.2.	GK NAP	Autumn search	3,58	6,38	3,02	39,08	81,52	46,58
Bem.2.	GK PETUR	Autumn search	3,40	6,74	2,83	39,23	77,13	62,41
Bem.2.	GK VERECKE	Autumn search	3,24	6,73	2,76	40,00	79,47	67,68
Bem.3.	GK ATI	Autumn search	3,23	5,85	2,98	37,27	77,83	71,99
Bem.3.	GK BÉKÉS	Autumn search	3,34	6,85	2,89	39,80	75,70	68,69
Bem.3.	GK CSONGRÁD	Autumn search	3,12	6,04	2,85	36,51	74,42	41,39
Bem.3.	GK ÉLET	Autumn search	3,48	6,37	2,87	39,66	76,97	63,27
Bem.3.	GK GARABOLY	Autumn search	3,25	6,48	2,89	36,86	76,72	43,15

Bem.3.	GK HATTYÚ	Autumn search	3,56	6,34	2,88	37,91	77,72	25,32
Bem.3.	GK HOLLÓ	Autumn search	3,28	6,10	2,76	35,00	79,17	47,16
Bem.3.	GK KALÁSZ	Autumn search	3,31	6,36	2,71	36,43	77,12	66,95
Bem.3.	GK PETUR	Autumn search	3,29	6,51	2,76	38,06	75,93	58,21
Bem.3.	GK VERECKE	Autumn search	3,29	6,47	2,79	41,22	77,60	62,40
Bem.2.	GK ATI	Spring search	3,15	5,81	3,25	42,15	78,85	78,33
Bem.2.	GK BÉKÉS	Spring search	3,34	6,73	3,00	43,16	75,75	76,21
Bem.2.	GK CSONGRÁD	Spring search	3,15	5,98	2,92	43,25	75,73	48,83
Bem.2.	GK ÉLET	Spring search	3,42	6,68	2,91	41,13	78,00	69,87
Bem.2.	GK GARABOLY	Spring search	3,32	6,33	3,04	41,51	79,00	45,15
Bem.2.	GK HATTYÚ	Spring search	3,52	6,26	2,92	32,31	77,63	31,97
Bem.2.	GK HOLLÓ	Spring search	3,21	5,98	2,76	33,25	78,03	44,66
Bem.2.	GK KALÁSZ	Spring search	3,49	6,55	2,94	44,79	76,90	71,61
Bem.2.	GK NAP	Spring search	3,60	6,46	3,00	33,23	81,40	47,83
Bem.2.	GK PETUR	Spring search	3,37	6,54	2,93	41,31	77,00	62,13
Bem.2.	GK VERECKE	Spring search	3,30	6,48	2,78	44,39	79,00	66,66
Bem.3.	GK ATI	Spring search	3,16	5,78	2,96	41,19	77,85	72,71
Bem.3.	GK BÉKÉS	Spring search	3,30	6,70	2,99	44,92	75,95	70,16
Bem.3.	GK CSONGRÁD	Spring search	3,07	6,03	2,84	42,53	74,70	42,74
Bem.3.	GK ÉLET	Spring search	3,47	6,55	2,94	44,55	77,40	63,42
Bem.3.	GK GARABOLY	Spring search	3,26	6,28	2,99	34,74	77,28	43,81
Bem.3.	GK HATTYÚ	Spring search	3,42	6,12	2,86	34,09	77,60	25,68
Bem.3.	GK HOLLÓ	Spring search	3,13	5,96	2,66	39,26	79,13	48,54
Bem.3.	GK KALÁSZ	Spring search	3,48	6,55	2,86	34,68	77,18	64,18
Bem.3.	GK PETUR	Spring search	3,20	6,47	2,75	41,52	75,50	57,63
Bem.3.	GK VERECKE	Spring search	3,25	6,56	2,73	38,51	77,45	63,22

The Hardness Index of the examined samples did vary as Figure 1 also shows it. The SKCS 4100 classifies the results in two groups. Under 50, the wheat samples belong to Soft Wheat-, while samples above values 50 considered as Hard Wheat category. In our study we had 5 soft wheat varieties (GK Csongrád, GK Garaboly, GK Hattyú, GK Holló, GK Nap) and we had 6 hard wheat varieties (GK Ati, GK Békés, GK Élet, GK Kalász, GK Petúr, GK Verecke).

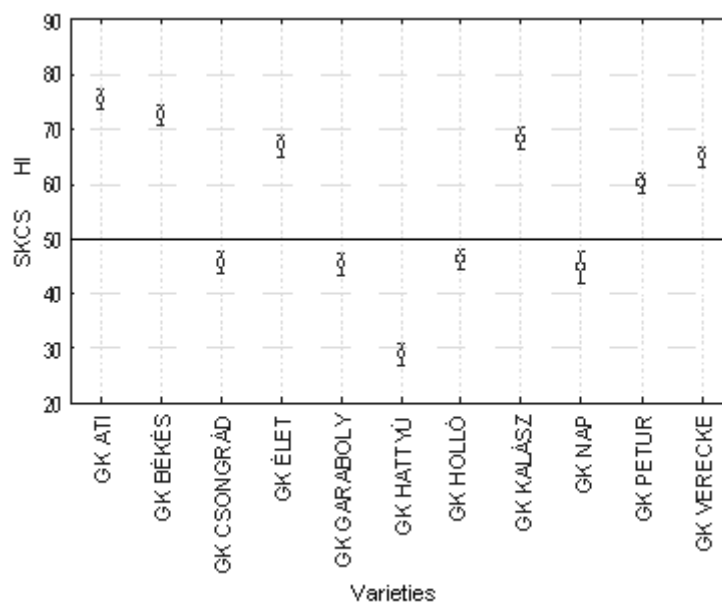


Figure 1. The Hardness Index of the varieties

Table 2 shows the results of the flour yield, ash content and other technological traits of the wheat samples.

Table 2. Selected technology parameters of the entries in the study

Harvest time	Variety		Flour yield (%)	Ash content (%/sz.a.)	Gluten index (%)	Wet gluten (%)	Dry gluten (%)	Gluten-ratio	Gluten-flattering (mm)
Bem.2.	GK ATI	Autumn search	72,19	0,68	83	35,38	12,26	2,89	0,9
Bem.2.	GK BÉKÉS	Autumn search	73,37	0,71	84	36,16	12,70	2,85	1,1
Bem.2.	GK CSONGRÁD	Autumn search	70,55	0,68	76	33,53	11,47	2,92	1,8
Bem.2.	GK ÉLET	Autumn search	75,41	0,56	93	32,01	11,33	2,83	1,0
Bem.2.	GK GARABOLY	Autumn search	69,06	0,52	65	30,63	10,65	2,88	2,0
Bem.2.	GK HATTYÚ	Autumn search	67,32	0,49	80	28,53	9,83	2,90	0,8
Bem.2.	GK HOLLÓ	Autumn search	63,33	0,52	74	30,34	10,13	3,00	1,5
Bem.2.	GK KALÁSZ	Autumn search	66,89	0,62	91	32,67	11,50	2,84	0,5
Bem.2.	GK NAP	Autumn search	70,91	0,51	71	32,26	11,18	2,89	1,9
Bem.2.	GK PETUR	Autumn search	76,43	0,52	98	29,98	10,59	2,83	0,8
Bem.2.	GK VERECKE	Autumn search	75,89	0,53	98	26,31	9,33	2,82	0,5
Bem.3.	GK ATI	Autumn search	75,86	0,66	56	35,11	12,31	2,85	2,0
Bem.3.	GK BÉKÉS	Autumn search	74,28	0,72	73	38,46	13,42	2,87	1,5
Bem.3.	GK CSONGRÁD	Autumn search	68,60	0,63	68	32,95	11,32	2,91	1,6
Bem.3.	GK ÉLET	Autumn search	74,19	0,54	92	30,47	10,74	2,84	0,5
Bem.3.	GK GARABOLY	Autumn search	69,74	0,53	61	30,49	10,58	2,88	2,3
Bem.3.	GK HATTYÚ	Autumn search	67,56	0,48	67	28,34	9,82	2,89	0,8
Bem.3.	GK HOLLÓ	Autumn search	68,73	0,61	60	31,68	10,74	2,95	2,5

Bem.3.	GK KALÁSZ	Autumn search	77,29	0,74	93	32,94	11,61	2,84	0,8
Bem.3.	GK PETUR	Autumn search	75,24	0,59	95	30,47	10,72	2,84	1,1
Bem.3.	GK VERECKE	Autumn search	76,89	0,56	96	26,01	9,26	2,81	0,8
Bem.2.	GK ATI	Spring search	67,86	0,60	67	35,64	12,56	2,84	1,4
Bem.2.	GK BÉKÉS	Spring search	69,31	0,64	78	35,56	12,51	2,84	0,8
Bem.2.	GK CSONGRÁD	Spring search	61,60	0,50	53	32,19	11,16	2,88	2,4
Bem.2.	GK ÉLET	Spring search	71,05	0,48	79	31,61	11,20	2,82	1,0
Bem.2.	GK GARABOLY	Spring search	64,77	0,49	45	29,86	10,50	2,84	1,9
Bem.2.	GK HATYÚ	Spring search	66,85	0,46	64	26,33	9,27	2,84	0,9
Bem.2.	GK HOLLÓ	Spring search	62,16	0,49	70	30,53	10,42	2,93	1,6
Bem.2.	GK KALÁSZ	Spring search	68,39	0,55	83	32,98	11,50	2,87	1,1
Bem.2.	GK NAP	Spring search	63,75	0,46	75	30,83	10,88	2,83	1,5
Bem.2.	GK PETUR	Spring search	70,05	0,51	87	30,03	10,57	2,84	1,1
Bem.2.	GK VERECKE	Spring search	71,66	0,48	93	26,86	9,52	2,82	0,8
Bem.3.	GK ATI	Spring search	71,51	0,58	73	35,70	12,51	2,85	1,8
Bem.3.	GK BÉKÉS	Spring search	71,05	0,62	69	37,78	13,29	2,84	1,1
Bem.3.	GK CSONGRÁD	Spring search	63,09	0,55	54	32,53	11,14	2,92	2,1
Bem.3.	GK ÉLET	Spring search	72,43	0,49	81	31,32	10,96	2,86	0,6
Bem.3.	GK GARABOLY	Spring search	65,59	0,49	54	29,41	10,32	2,85	2,4
Bem.3.	GK HATYÚ	Spring search	65,34	0,43	69	27,54	9,47	2,91	1,1
Bem.3.	GK HOLLÓ	Spring search	62,65	0,47	55	30,67	10,42	2,94	2,8
Bem.3.	GK KALÁSZ	Spring search	70,27	0,58	87	34,02	11,91	2,86	0,6
Bem.3.	GK PETUR	Spring search	70,03	0,47	95	29,67	10,52	2,82	0,9
Bem.3.	GK VERECKE	Spring search	73,01	0,49	97	25,56	9,03	2,83	0,5

Table 3 shows the results of the alveographic values and falling numbers of the wheat samples. The alveograph characteristics of wheat flour showed that the maximum over pressure (P), a measure of dough elasticity, varied from 54.34 to 125.84 mm in the autumn research, and from 58.3 to 136.4 mm in the spring research. The average abscissa at rupture (L), which is a measure of dough extensibility, ranged from 103 to 140 mm in the autumn research, and 81.5 to 146 mm in spring research. The values for curve configuration ratio, indicating the ratio of elasticity to extensibility of the dough varied between 0.351 and 1.126 in the autumn samples, and 0.47 to 1.67 in the spring samples. The values for deformation energy of dough (W) representing the energy necessary to inflate the dough bubble to the point of rupture ranged from 188.3 to 453.1×10^{-4} J in autumn research, and 209.7 to 475.7×10^{-4} J in spring samples.

Falling number gives an indication of the amount of sprout damage that has occurred within a wheat sample. Sprouting can affect food made from wheat in many ways. It can reduce mixing strength, cause sticky dough, and affect loaf volume and shelf life. In pasta, sprouting can reduce shelf life, increase cooking loss, and produce softer cooked pasta. Generally, a falling number value of 350 seconds or longer indicates low enzyme activity and very sound wheat. As the amount of enzyme activity increases, the falling number decreases. Values below 200 seconds indicate high levels of enzyme activity. The wheat samples showed a falling number between 320 and 453 s for the autumn research, and between 321 and 448 s for the spring research, respectively.

According to these characteristics, flours were all within a range of excellent bread making potential (P/L value between 0.5-0.9 and $W > 200$) or suitable for bread and baking flours (P/L value between 0.4-0.9 and W value between 170-310. Based on the falling number values, the 11 wheat variety both in the autumn and spring research showed low enzyme activity.

Table 3. Selected technology parameters of the entries in the study

Harvest time	Variety		P (mm)	L (mm)	P/L	W (x10 ⁻⁴ J)	Falling number (s)
Bem.2.	GK ATI	Autumn search	90,09	131,50	0,685	385,9	361
Bem.2.	GK BÉKÉS	Autumn search	125,84	103,50	1,216	443,4	442
Bem.2.	GK CSONGRÁD	Autumn search	83,49	124,50	0,671	258,3	394
Bem.2.	GK ÉLET	Autumn search	113,63	103,00	1,103	378,1	433
Bem.2.	GK GARABOLY	Autumn search	69,41	125,50	0,553	234,0	348
Bem.2.	GK HATYÚ	Autumn search	55,69	114,00	0,489	194,2	320
Bem.2.	GK HOLLÓ	Autumn search	75,57	126,00	0,600	241,5	396
Bem.2.	GK KALÁSZ	Autumn search	119,90	106,50	1,126	453,1	406
Bem.2.	GK NAP	Autumn search	68,75	125,00	0,550	254,3	352
Bem.2.	GK PETUR	Autumn search	61,60	140,00	0,440	256,1	381
Bem.2.	GK VERECKE	Autumn search	84,26	117,00	0,720	311,8	417
Bem.3.	GK ATI	Autumn search	79,31	117,00	0,678	272,0	372
Bem.3.	GK BÉKÉS	Autumn search	112,31	111,50	1,007	401,5	437
Bem.3.	GK CSONGRÁD	Autumn search	77,00	127,00	0,606	240,7	432
Bem.3.	GK ÉLET	Autumn search	103,40	106,50	0,971	359,6	449
Bem.3.	GK GARABOLY	Autumn search	65,67	124,00	0,530	222,8	322
Bem.3.	GK HATYÚ	Autumn search	54,34	115,00	0,473	194,1	338
Bem.3.	GK HOLLÓ	Autumn search	69,08	116,00	0,596	188,3	409
Bem.3.	GK KALÁSZ	Autumn search	111,10	111,00	1,001	415,1	453
Bem.3.	GK PETUR	Autumn search	56,65	161,50	0,351	284,8	394
Bem.3.	GK VERECKE	Autumn search	74,36	117,00	0,636	265,1	450
Bem.2.	GK ATI	Spring search	95,5	115,5	0,83	383,7	369
Bem.2.	GK BÉKÉS	Spring search	133,8	95,5	1,40	443,2	443
Bem.2.	GK CSONGRÁD	Spring search	83,2	116,5	0,71	264,2	381
Bem.2.	GK ÉLET	Spring search	119,9	93,0	1,29	393,7	422
Bem.2.	GK GARABOLY	Spring search	65,1	107,5	0,61	209,7	321
Bem.2.	GK HATYÚ	Spring search	60,1	109,0	0,55	213,9	338
Bem.2.	GK HOLLÓ	Spring search	85,8	111,0	0,77	267,2	365
Bem.2.	GK KALÁSZ	Spring search	135,1	94,0	1,44	475,7	421
Bem.2.	GK NAP	Spring search	73,5	119,0	0,62	266,2	354
Bem.2.	GK PETUR	Spring search	68,4	146,0	0,47	305,5	391
Bem.2.	GK VERECKE	Spring search	97,0	101,5	0,96	333,0	411
Bem.3.	GK ATI	Spring search	100,1	100,5	1,00	342,7	371
Bem.3.	GK BÉKÉS	Spring search	136,4	93,0	1,47	445,0	448
Bem.3.	GK CSONGRÁD	Spring search	91,3	107,0	0,85	260,4	382
Bem.3.	GK ÉLET	Spring search	129,3	82,5	1,57	370,2	427
Bem.3.	GK GARABOLY	Spring search	76,1	90,5	0,84	213,9	357
Bem.3.	GK HATYÚ	Spring search	58,3	117,0	0,50	220,0	306
Bem.3.	GK HOLLÓ	Spring search	79,5	102,0	0,78	227,5	354
Bem.3.	GK KALÁSZ	Spring search	136,4	81,5	1,67	438,8	442
Bem.3.	GK PETUR	Spring search	74,5	128,0	0,58	317,9	377
Bem.3.	GK VERECKE	Spring search	90,6	104,0	0,87	315,2	398

The wheat was tested for significance using analysis of variance techniques (ANOVA).

Table 4. Results of analysis of variance (level of significance of $p < 0.05$)

Methods	Connection	
Flour Yield	S.	↓
Flour Ash	S.	↓
Gluten Index	S.	↓
Wet Gluten	N.S.	↓
Dry Gluten	N.S.	↓
Gluten Ratio	N.S.	↓
Gluten Flattering	N.S.	↑
Falling Number	N.S.	↓
Water Absorption Capacity	S.	↓
Value Number	S.	↑
P	S.	↑
L	S.	↑
P/L	S.	↑
W	S.	↑

S.- Significant

N.S.- Non Significant

Figure 2 shown that the flour yield is decreased, the statistical behaviour show it.

The gluten index is very important parameter behaviour of the flour; its value is a criteria defining whether the gluten quality is weak, strong or normal. The Gluten Index Method can be used for detection of heat and insect damage. Excessive heating will cause protein denaturation and decrease the wet gluten/protein ratio or destroy the ability to form gluten. Insects that damage wheat produce an enzyme that weakens the gluten bonds. During the storage, it is decreased (4 %).

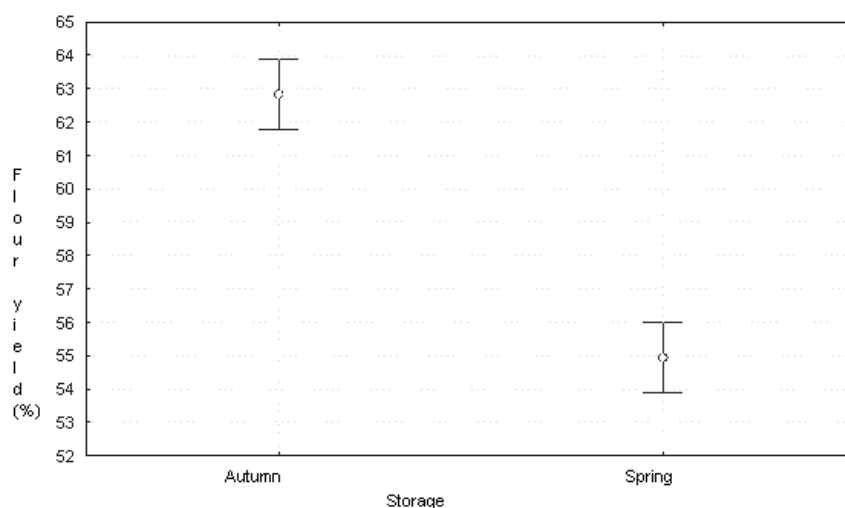


Figure. 2. Flour yield at a confidence interval of 0,95

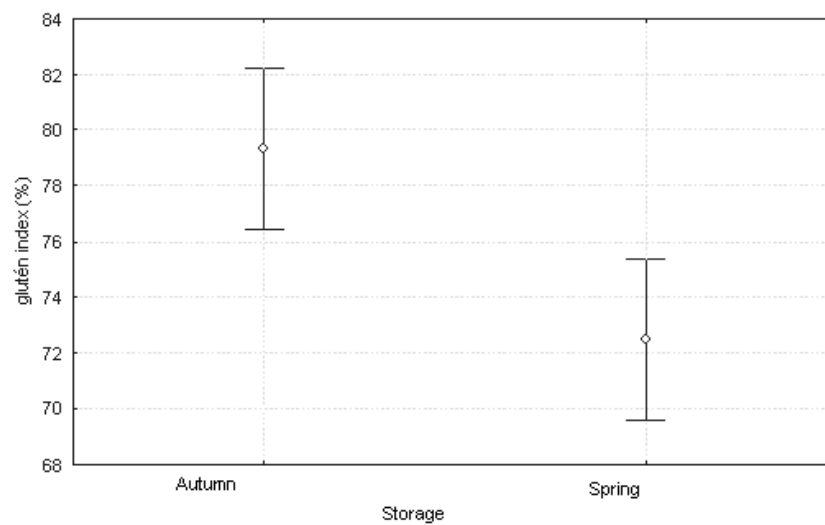


Figure 3. Gluten index at a confidence interval of 0,95

The water absorption capacity is decreased during the short time storage (Figure 4.)

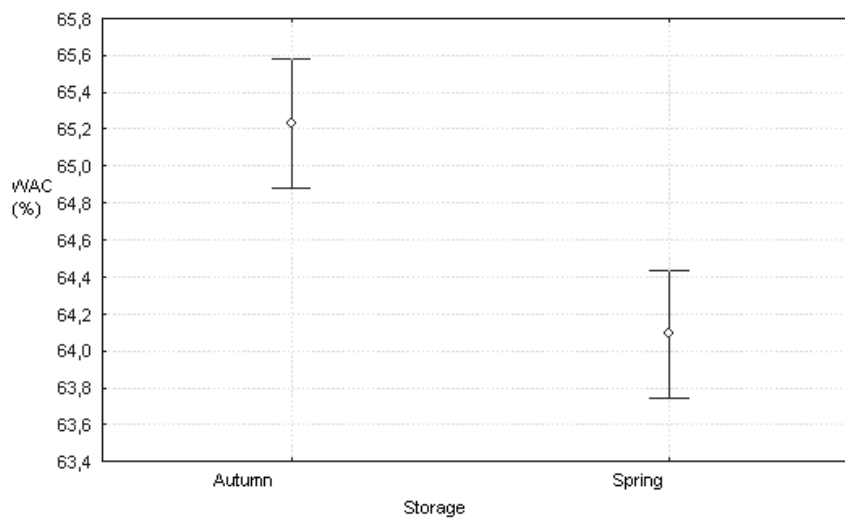


Figure 4. Water absorbance capacity at a confidence interval of 0,95

The P value and W value of alveograph is increased during the 6 months storage.

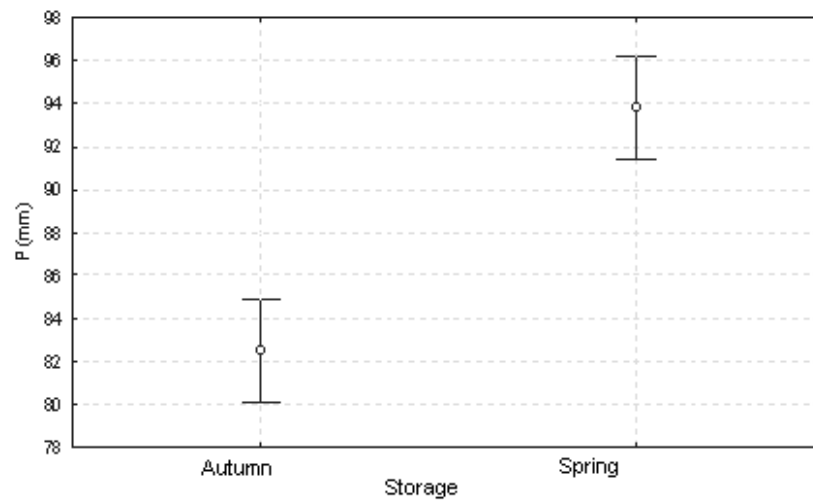


Figure 5. P value of alveograph confidence interval

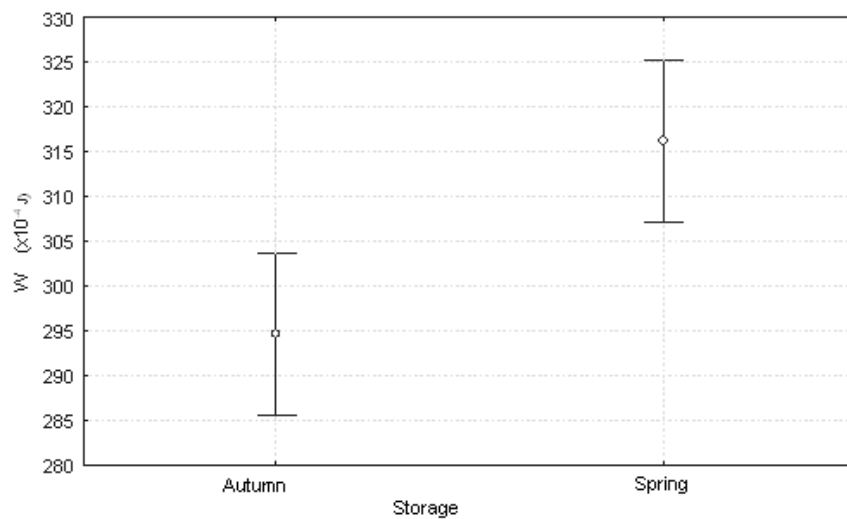


Figure 6. W value of alveograph confidence interval

4. CONCLUSIONS

Eleven different Hungarian wheat varieties were examined in our study. The physical properties and the flour quality were analyzed. The physical behaviour has not changed during storage either for 3 months or 9 months.

The hardness index average was 73.18 of the Bem. 2. in the autumn research, and 72.49 in the spring research. The hardness index average was 67.19 of the Bem. 3. in the autumn research and 67.96 in the spring research.

The flour yield has decreased by 4% in average. The Bem. 2. had 74.04 % flour yield in the autumn research, and 69.76 % in spring research. The Bem. 3. had 76.37 % flour yield in the autumn research, and 72.26 % in spring research.

The gluten index showed a similar trend, the Bem. 2. had 90.5 % gluten index in the autumn research, and 80 % in spring research. How about the Bem. 3.

The water absorption capacity has also decreased significantly during the investigated time interval.

The test by the alveograph have shown that the W value has increased significantly. The W value was 348.85 of the Bem. 2. in the autumn research, and 358.35 in spring research. The W value was 268.55 of the Bem. 3. in the autumn research, and 328.95 in spring research.

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