Variations in Quality Parameters of Forage and Medium Quality Winter Wheat Varieties in Storage

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Summary

Our investigation aimed to find out the type and volume of certain qualitative and microbiological changes in various fodder winter wheat varieties and also their similarity to the changes of quality parameters in the storage of improving winter wheat varieties.

Laboratory experiments on wheat samples included moisture and protein content, Hagberg's falling number, wet gluten content, alveographic values, and microbiological tests. The examined winter wheat varieties ('Magor', 'Hunor', 'Róna' and 'Kondor') retained their moisture, protein content, and their Hagberg's falling number after storage. A slight increase was observed in wet gluten content for all four winter wheat varieties after 129 days of storage. This result proved the theory of after-ripening, as gluten percentage improved both qualitatively and quantitatively. An approximate 10% increase in quantitative growth was observed for all four winter wheat varieties.

We placed a special emphasis on measuring the alveographic W (10^{-4} J) values during storage. All four winter wheat varieties showed decreasing values of about 20-40%.
Microbiological examinations on the four winter wheat varieties showed that mould, mould flora and total germ count remained balanced, with some slight variations, and that they did not change in terms of time under optimal storage conditions.

The changes in the tendency, type, and volume of the five qualitative parameters in the studied four forage wheat varieties and poor baking quality winter wheat varieties during storage showed similarities as compared to that of earlier described and studied improving winter wheat varieties.

Key words

winter wheat, storage, quality changes, microbiology

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Introduction

The major goal of our agricultural work was to determine how and in what way we can store the produced wheat, while paying careful attention to maintaining quality. Nowadays, this is the most important question for farmers and traders. Because of this issue and that history has demonstrated that different wheat-lots are being stored for years until processing, we should research the quality changes of different winter wheat varieties (not only improving wheat varieties, but also forage quality winter wheat varieties) after storage.

With respect to storage conditions for wheat, Barabas (1987) and Tomay (1987) categorized four groups in their reference book - one group suitable for storage, one group suitable for temporary storage, one group not suitable for storage and one group permanently susceptible to risks.

Győri (1999) analyzed the Hagberg's falling number during ten months storage and found no unanimous moderation.

In the seeds of stored wheat, several separated good-definable and several interaction processes may happen. The after-ripening process is one in which the synthetic-processes still go on, as the quality of wet gluten improves.

No significant change in wet gluten content was found during storage. In contrast, gluten quality increased at the end of the maturing period, due to the formation and stabilisation of gluten shell (Balla, Bedő, Láng, 1993).

The maximum moisture content of winter wheat, according to the Hungarian Standards 6383:1998, is 14.5%, but the experiences show that the wheat can be stored without decline in quality for a significant time, when its moisture content is around 13%. Wheat whose moisture content is above 16% can not be stored (Mesterházy, 1997). If the optimal microclimate is proved, the number of microorganisms increases and the activity of toxin producing funguses may raises.

The alveographic tests were implemented within the past few years. Depending on various storage conditions the alveographic W values of different winter wheat varieties can be decreased by 30-40 percent (Győriné, 2005).

Komka (2001) has analyzed the microbiological damage that varying moisture contents have on stored grain. He found that, the microbiological damage and the mould count were decreased when the moisture content was between 17.0 -18.0% and the grain was stored in a ventilated room. The storing of grain with similar moisture content but without ventilation is admissible for 15 days because of the grown mould flora.

The quality, substance, and clearness of stored grain significantly influence the microbiological composition. Under optimal storage conditions (optimal quality and moisture content) winter wheat can be stored for a long time without quality losses and the increase of mould count. After a few months storage, microbiological examinations showed the grain damage increased the germ and mould count (Veres, 2004).

There are several sources; the circumstances of storage influence the microbiological conditions and toxin impurity of the winter wheat. It is important to ensure the expert storage conditions to keep the desired quality of the grain (Veres, 2005).

Material and methods

Analyzed samples are from Hungary, Jász-Nagykun-Szolnok County University of Debrecen and Agricultural Centre Karcag Research Site. All the examined varieties were hard red winter wheat; harvested in 2005. The varieties are called: 'Magor', 'Hunor', 'Róna' and 'Kondor'.

After harvesting the wheat samples were stored in sacks in the storage of the Central Laboratory of Hajdú Gabona Ltd. The storing time was 129 days and the amounts of the samples were 40 kg per variety. The temperatures of the varieties at the time of depositing them in the storage room ranged between 15-17 °C and over the 129 days storage the temperature was kept at 10-13 °C. The cleaning was done according to the Hungarian standard MSZ 6367-2:2001 with screens with diagonally placed holes of 2.5-1.1 mm. The moisture in the wheat seeds was between 13.15-14.35 %. From October we took samples on every second week. Laboratory test were conducted in the Central Laboratory of Hajdú Gabona Ltd. and the Central Laboratory of the University Of Debrecen, Centre Of Agricultural Sciences: moisture content, wet gluten content, protein content, Hagberg's falling number and alveographic tests. Microbiological tests were made done by the Central Laboratory of Agricultural Consultative Centre, Debrecen.

From the wheat – after convenient sample-preparing – the flour was done according to the Hungarian standard MSZ 6367/9:1989, using a LABOR MIM FQC 109 and a PERTEN LABORATORY MILL 3100. The laboratory tests were done according to the effective and required MSZ, MSZ ISO standards and AACC method (Table 1).

The moisture content was determined from 5 g ground material after drying in an oven at 130°C for 2 hours.

The protein content was determined by the Kjeldahl-method from 1 g ground material after concentrated sulphuric acid destruction and ammonia discharging.

We determined the Hagberg's falling number from 7 g known moisture contented ground material. We put the diluted solution of the sample into a viscometer tube, and then it put into boiling water bath with a viscometer

Table 1. The examined quality parameters

Indexes measures	Method	Instrument
Moisture content	MSZ 6367-3:1983	Airing cupboard
Protein content	MSZ 6367-11:1984	Khjel-Tech 1026
Wet gluten content	MSZ ISO 5531:1993	Perten T 2000
Falling number	MSZ ISO 3093:1995	Perten 1500
Alveographic value	AACC-1983.54.30	Chopin MA 87 typ.
Total germ	MSZ ISO 4833	TGE nutrient substratum
Mould count	MSZ ISO 7954	YGC nutrient substratum

stirrer in it, and started the stopper. When the viscometer stirrer reached the bottom of gelatinized solution, the test was completed. The time on the stopper constitutes the falling number.

Wet gluten content was determined from 10 g flour after making dough with sodium chloride solution.

We engraft 1 ml from convenient dilution lines on nutrient substratum (total germ – TGE, mould count – YGC). Then we put them into an incubator on 30 °C for 5 days. After the fifth day we count the germ beds and determine the microbiological parameters.

After calibrating the alveograph, we put into its kneader husk 250 g known moisture contented flour. We add to the flour sodium chloride solution. After mixing the dough we make five paste discs. We put then into thermostat and at the end of the 28 minutes we make dough-bubbles from the discs. The alveographic parameters were deterimned from the five curves.

The results of the tests were evaluated by Word 11.5 for Windows and Excel 6.0 for Windows programs, the figures and tables were made by Excel 6.0 for Windows program. In preparing the thesis the average and standard deviation values and CV% values found in the tables were calculated by using Microsoft Word and Microsoft Excel programs. In order to more precisely identify the trends in the diagrams, smoothed the average values are indicated and there are also trend-lines to illustrate the directions of the changes.

Results and discussion

The moisture content of the four examined winter wheat varieties (Magor, Hunor, Róna and Kondor) did not change during storage. It is established, the moisture content is stable The CV% values were the following: Magor: 0.32; 'Hunor': 0.20; 'Róna': 0.22 and 'Kondor': 0.27 (Table 2).

The protein content of the examined four winter wheat varieties ('Magor', 'Hunor', 'Róna' and 'Kondor') did not change during storage either. Taking into consideration the results of the four winter wheat varieties it is claimed, the standard deviation values are around 0.2% and the CV% values were between 1.42 – 2.32% (Figure 1).

Table 2. Changes in moisture content with storage time (m/m%)

Sampling time	Magor	Hunor	Róna	Kondor
2005.10.10	13.80	13.15	14.35	13.22
2005.10.21	13.97	13.47	14.42	13.62
2005.11.07	13.75	13.17	14.22	13.71
2005.11.17	13.62	13.11	14.09	13.52
2005.12.12	14.34	13.33	14.52	13.87
2006.01.05	13.63	12.88	14.05	13.10
2006.01.23	14.27	13.42	14.46	13.81
2006.02.16	13.46	13.06	13.89	13.49
Average	13.86	13.20	14.25	13.54
Standard deviation	0.32	0.20	0.22	0.27
CV%	2.31	1.52	1.54	1.99

The wet gluten content showed a slight, equable growth, during storage. During the 129 days of storage, the wet gluten content of the examined four winter wheat varieties ('Magor', 'Hunor', 'Róna' and 'Kondor') increased about 10%. This result proves the after-ripening theory.

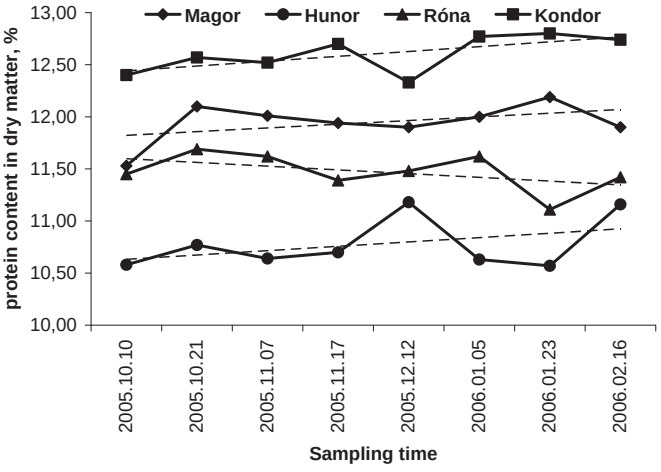

Figure 1.
Changes in protein content with storage time (m/m%)

The standard deviations were between 0.88% and 1.35%. The CV% values were between 3.8% and 5.3% (Figure 2).

The values of the Hagberg's falling numbers of the examined four winter wheat varieties (Magor, Hunor, Róna and Kondor) were very different from each other at the beginning of storing. The average values were the following: 'Magor': 341 sec, 'Hunor': 462 sec, 'Róna': 383 sec, and 'Kondor': 358 sec. The standard deviations and the CV% values in the same row: 11.11 – 3.25; 17.13 – 3.70; 10.74 – 2.80 and 15 – 4.2. It is claimed the Hagberg's falling number did not change during the storage (Table 3),

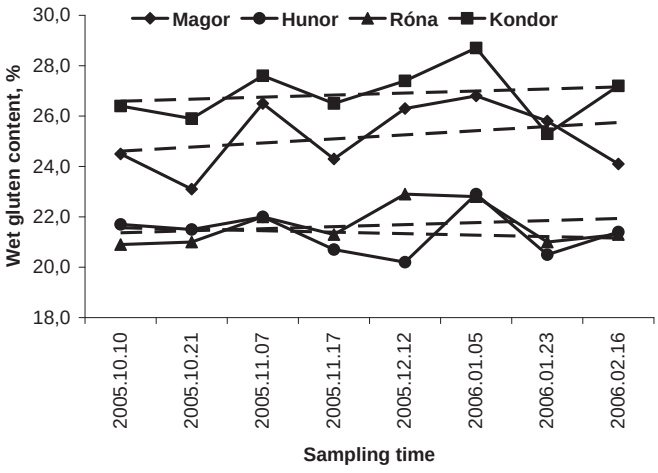

Figure 2.
Changes in wet gluten content with stoage time (m/m%)

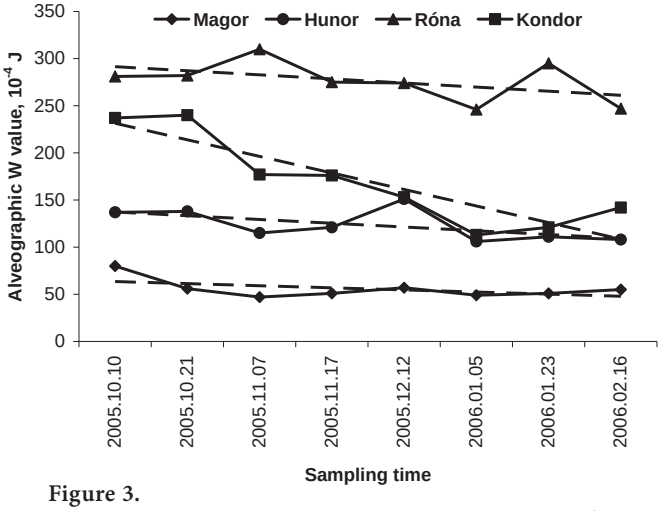

Figure 3.
Changes in alveographic W values with storage time (10^{-4} J)

Table 3. Changes in Hagberg's falling number with storage time (sec)

Sampling time	Magor	Hunor	Róna	Kondor
2005.10.10	334	437	388	355
2005.10.21	324	477	392	344
2005.11.07	333	480	369	363
2005.11.17	345	463	402	353
2005.12.12	328	455	374	373
2006.01.05	339	479	387	365
2006.01.23	344	441	389	326
2006.02.16	359	451	377	366
Average	341.33	461.50	383.00	357.67
Standard deviation	11.11	17.13	10.74	14.99
CV%	3.25	3.70	2.80	4.20

therefore the wheat did not start to sprout in storage, so the activity of the of the α-amylase enzyme did not increase, which is why the value of the Hagberg's falling number did not change in either way.

We placed a special emphasis on measuring the alveographic parameters, during storage, as with the opening of EU market; these parameters will gain a special significance.

We examined the change of the alveographic P (mm), L (mm), P/L, G (ml) and W (10^{-4} J). The most apparent changes were experienced in the value of the alveographic W. All the examined four winter wheat varieties ('Magor', 'Hunor', 'Róna' and 'Kondor') showed decreasing values of about 20-40%. The decrease of this rheological parameter can be explained by the change of structure of wheat protein during storage. However, fixing this fact, further research is needed (Figure 3).

During the microbiological examinations of the examined four winter wheat varieties ('Magor', 'Hunor', 'Róna' and 'Kondor') determined, the mould, mould flora – especially the fusarium count – and total germ count. It is claimed these parameters did not change with storage time, under optimal conditions (Table 4). It can be explained by this fact: the wheat was stored with optimal moisture content in a well-ventilated room where the humidity was fair enough.

Table 4. Changes in microbiological parameters with storage time

Sampling time	Microbiological examinations											
	Magor			Hunor			Róna			Kondor		
	Mould count	Fusarium	Total germ	Mould count	Fusarium	Total germ	Mould count	Fusarium	Total germ	Mould count	Fusarium	Total germ
2005.10.21	300	0	19 000	100	0	21 000	13 000	2 000	83 000	10	0	11 000
2005.11.07	100	0	9 800	300	0	11 500	14 000	3 000	83 000	100	0	1 100
2005.12.12	100	0	45 000	100	0	76 000	5 000	0	76 000	100	0	5 600
2005.12.24	100	0	45 000	100	0	76 000	5 000	0	76 000	100	0	5 600
2006.01.23	100	0	42 000	100	0	69 000	6 700	0	73 000	100	0	3 100
2006.02.28	70	0	41 000	230	0	57 000	6 800	1 300	85 000	120	100	6 100
2006.03.21	100	0	39 000	120	0	66 000	5 900	0	81 000	100	0	4 900

Conclusions

The examined winter wheat varieties 'Magor', 'Hunor', 'Róna' and 'Kondor') retained their moisture content at the onset storage; it did not change during storage.

Tests on their protein content also showed that this quality parameter remained unchanged, showing balanced and stable values during storage.

The variations of Hagberg's falling number remained within the allowed limits of the test method (±5%). Winter wheat varieties retained their falling numbers measured at harvest and at storage, under these optimal storage conditions.

A slight growth could be experienced in the values of wet gluten content for all the four winter wheat varieties in terms of the duration of storage (129 days). Winter wheat varieties not only retained their gluten percentage measured at harvest, but this indicator showed even higher values. This result proved the theory of after-ripening, when gluten percentage improves qualitatively and quantitatively as well. Quantitative growth lasted until January 2006; its value was about 10% for all the four winter wheat varieties.

An opposite tendency can be claim in the values of the alveographic W. The decreasing of it, was 20 – 40%.

Microbiological examinations on the four winter wheat varieties showed that mould, mould flora and total germ count remained balanced with some slight variations and they did not change in terms of time under optimal storage conditions.

The changes in the tendency, type and volume of the five qualitative parameters in the studied four forage and poor baking quality winter wheat varieties ('Magor', 'Hunor', 'Róna' and 'Kondor') during storage showed similarities as compared to that of earlier described and studied improving winter wheat varieties.

References

Balla, L., Bedő, Z., Láng, L., (1993): A búza minősége. Gabonaipar XL. 4. 1-2

Barabás, Z. (1987): A búzatermesztés kézikönyve. Mezőgazdasági Kiadó. Budapest

Győri, Z. (1999): Mezőgazdasági termékek tárolása és feldolgozása. Egyetemi jegyzet, DATE, Debrecen.

Győri, Z (2005): A búza minőségét befolyásoló tényezők a betakarítástól a felhasználásig. Szakdolgozat

Komka, Gy. (2001): Minőségi szemestermény tárolás. Agronapló, 5. 8. 14-18.

Mesterházy, Á. (1997): A szántóföldi növények mikrobiális patogén szennyeződésének csökkentése, humán egészségügyi minőségének javítása. „Agro 21" Füzetek 1997. 14. 90-130

Tomay, T. (1987): Gabonatárolás. Gabona Tröszt, Budapest

Veres, E. (2004): Őszi Búza fusarium fertőzöttségének és mikotoxin szennyezettségének vizsgálata, Debreceni Agrártudományi Egyetem. Debrecen

Veres, E; Borbély, M. (2005): Az őszi búza felhasználhatósága a vizuális és mikrobiológiai fusarium fertőzöttség- valamint a toxinvizsgálatok alapján, Debreceni Agrártudományi Egyetem. Debrecen

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