Flour quality and kernel hardness connection in winter wheat

Balázs P. Szabó
e-mail: szpb@mk.u-szeged.hu
University of Szeged, Faculty of Engineering,
H-6725 Moszkvai krt. 5-7., Szeged, Hungary

Ernő Gyimes
e-mail: gyimes@mk.u-szeged.hu

Antal Véha
e-mail: veha@mk.u-szeged.hu
University of Szeged, Faculty of Engineering,
H-6725 Moszkvai krt. 5-7., Szeged, Hungary

Zsuzsanna H. Horváth
e-mail: horvatzs@mk.u-szeged.hu
University of Szeged, Faculty of Engineering,
H-6725 Moszkvai krt. 5-7., Szeged, Hungary

Keywords and phrases: wheat kernel, flour parameters, SKCS 4100

Abstract. Kernel hardness controls by friabilin protein and it depends on the relation between protein matrix and starch granules. Friabilin presents in high concentration in soft grain varieties and it is low concentration in hard grain varieties. The high gluten, hard wheat flour generally contains about 12.0-13.0 % crude protein under Mid-European conditions. The relationship between wheat protein content and kernel texture is usually positive and kernel texture influences the power consumption during milling. Hard textured wheat grains require more grinding energy than soft textured grains.

The aim of our research was to determine the possible relationship between kernel hardness and various other parameters of the flour (dough visco-elastic characteristics, wet gluten, water absorption, flour recovery, alveograph). We used Perten SKCS 4100 to determine the kernel hardness, while the Perten 3303 mill was used to establish Particle Size Index (PSI). Registered and widely

used Hungarian wheat varieties (7 of HRWW and 4 of SRWW) were applied in the study. Twin correlations were used to determine the relationship among the various traits.

According to the results, there is a very strong correlation between the milling energy and the kernel hardness (r=0.99). The correlation between hardness index and the examined flour parameters was also significant (r=0.81-0.87). We found strong correlation between the milling energy and water absorption (r=0.878) of the flour. The associations found in this study will help to better understanding the wheat grain and flour quality technological aspects.

1 Introduction

The kernel hardness have great effect on the resulting flour's baking properties. Flour, which is made from hard wheat have a medium to high protein content and stronger gluten forming proteins than flour, which is made from soft wheat.

Kernel texture is very strongly heritable in wheat. The friabilin protein determines the kernel hardness. When the amount of the friabilin is high, the kernel hardness is soft and when the amount of the friabilin is low the kernel hardness is hard. We can sort in these two groups the kernel hardness (*Greffeuille et al.,* 2006). Hardness in wheat is largely controlled by genetic factors but it can be affected by the environment and other factors such as lipid, moisture, and pentosan content. Friabilin, a marker protein for grain softness, consists of two proteins, puroindoline a and b (*Martin et al.,* 2006). The lipid binding proteins puroindolines a (PINA) and b (PINB) have been identified as responsible in determining differences between hard and soft textured wheat. (*Gyimes,* 2004*; Gyimes et al.,* 2001)

The high gluten, hard wheat flour generally contains about 12.0-13.0 % crude protein under Mid-European conditions. The relationship between wheat protein content and kernel texture is usually positive and kernel texture influences the power consumption during milling. Hard textured wheat grains require more grinding energy than soft textured grains (*Békési,* 2001).

The good mill and baker quality wheat belong to the hard grain type. As well as the mill industry and the baker industry (making of bread) prefer this type. The hard endosperm composition is in close relationship with the large flour yield (from amongst the better is the greater ratio of the more valuable fraction), with the flour's greater water consumption, the

volume of the bread, the bread's quality parameters (inner, height etc.) and the protein content (*Veha,* 1999).

For the determination and measuring of the endosperm structure, kernel hardness indicators were made, which measures the power needed to snap a seed. With this method, they determine a ration: Hardness Index (HI), which is one of the bases of mill crop's acceptance qualification.

2 Objectives

The aim of the kernel hardness determines. In our investigation we have used the Perten SKCS 4100, the Perten 3303 mill. We used Hungarian as samples. Registered and widely used Hungarian wheat varieties (7 of HRWW and 4 of SRWW) were applied in the study, which were labelled with code number.

3 Measurement Methods

The Perten SKCS 4100 instrument (Figure 1.) is one of the well know machines, which examine the kernel hardness. This device measures kernel texture by crushing the kernels, recording the force required to crush the kernel. This machine reports the average force for crushing 300 kernels, in terms of a hardness index (HI). The SKCS-4100 can complete a test in about 3 minutes, and simultaneously reports mean and standard deviation data for diameter, kernel weight, and moisture content, and the HI. (*Szabó,* 2006)

Figure 1. Perten SKCS 4100 instrument

We used Perten 3303 mill (Figure 2.) to determine the Particle Size Index (PSI). This involves grinding a sample, and sieving a weighed amount through a standard screen for a standard time. The percentage of throughs is recorded as the PSI. We determine the specific grind energy pretence (e_f). All measurements were repeated 3 times.

Figure 2. Perten 3303 laboratory mill

We measured the dough visco-elastic characteristics water absorption, wet gluten and alveograph.

Milling test: Brabender ® Quadrumat ® Senior (Brabender GmbH & Co. KG, Duisburg, Germany) laboratory mill checking the milling properties of different types of grain and determining the flour yield (FL) of the wheat sample.

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: We used the Brabender ® farinograph (Brabender GmbH & Co. KG, Duisburg, Germany). The farinograph determines dough and gluten properties of a flour sample by measuring the resistance of dough against the mixing action of blades.

Alveograph characteristics: Chopin Alveorgraph NG (CHOPIN Technologies, Villeneuve-la-Garenne Cedex, France) the alveograph test were determined according to the EU-Standards. The results include P Value, L Value, P/L Value and W Value.

4 Results

Result of flour (Table 1.)

Table 1: Flour parameters

Samlpe code	Moisture (%)	Milling (%)	Water absorbant	Wet gluten (%)	Alveograph			
					P	L	P/L	W
II.	13.27	71.88	54.8	21.58	42.4	65.5	0.65	102.06
III.	13.86	71.79	57.3	27.48	63.49	93.75	0.68	204.54
VI.	14.01	74.01	54	16.85	45.72	51.5	0.89	103.99
IX.	14	68.33	56.6	25.3	49.99	67.3	0.75	123.8
IV.	13.9	72.89	60.9	28.13	88.25	70	1.26	251.35
VII.	13.85	71.28	61.4	22.88	105.5	43	2.45	195.84
VIII.	13.58	70.16	63.2	33.68	87.95	75.5	1.14	226.64
X.	13.37	70.96	67.9	31.7	93.18	59.9	1.56	178.48
XI.	13.15	67.94	66.8	35.6	100.3	47	2.16	189.91
XII.	12.82	70.46	63	29.68	103.9	61.45	1.69	252.19
XIII.	12.92	69.66	56.9	31.08	54.85	66	0.83	148.09

Results of Perten SKCS 4100 and Perten 3303 mill (Table 2.)

Table 2: Results of SKCS 4100 and Perten 3303 mill

Samples	Perten SKCS 4100 (HI %)	Perten 3303 mill (e_f mWh/cm^2)
II.	27	0.235
III.	36	0.245
VI.	20	0.215
IX.	29	0.255
IV.	61	0.44
VII.	57	0.435
VIII.	67	0.465
X.	81	0.555

XI.	81	0.545
XII.	81	0.535
XIII.	68	0.47

The SKCS 4100 compartmentalize the results in two groups. Fewer than 50 is soft grain (the hardness index was between 27-36). Above 50 is hard grain (the hardness index was between 57-81).

We use twin correlation to determine the relationship among the results.

Table 3: Correlation matrix for the technological traits and grinding energy of wheat entries in Szeged, Hungary

		Perten Hardness Index HI (%)	Grinding energy (e_g mWh/cm^2)	Moisture (%)	Milling extraction (%)	Water absorbtion (ml)	Wet gluten (%)	Alveograph			
								P	L	P/L	W
Perten Hardness Index HI (%)		1									
Grinding energy (e_g mWh/cm^2)		0.991	1								
Moisture (%)		-0.637	-0.60	1							
Milling extraction (%)		-0.437	-0.417	0.417	1						
Water absorbtion (ml)		0.876	0.878	-0.346	-0.402	1					
Wet gluten (%)		0.833	0.781	-0.531	-0.660	0.756	1				
A	P	0.816	0.826	-0.244	-0.224	0.873	0.560	1			
L	L	-0.217	-0.320	0.141	0.096	-0.260	0.171	-0.325	1		
V	P/L	0.640	0.687	-0.187	-0.240	0.724	0.300	0.875	-0.691	1	
E	W	0.675	0.634	-0.151	-0.055	0.623	0.582	0.808	0.209	0.468	1

Table 2 shows also the Perten-HI and grinding energy values in the tests. The SKCS 4100 compartmentalize the results in two groups. Under 50, the entries belong to Soft Wheat-, while entries above values 50 considered as Hard Wheat category. The average HI was 55.2 with minimum of 20 and maximum of 81 values.

According to the results, there is a very strong correlation between the milling energy and the kernel hardness (r=0.99) (Figure 3.). The correlation between hardness index and the examined flour parameters was also significant (r=0.81-0.87). We found strong correlation between the milling energy and water absorption r=0.878 of the flour. For example: hardness index – wet gluten r=0.833; hardness index – water absorption r=0.876 (Figure 4.), hardness index – P value of alveograph r=0.816. There is a correlation between the e_f and water absorption r=0.878. We found correlation the water absorption and P value of alveograph, r=0.873.

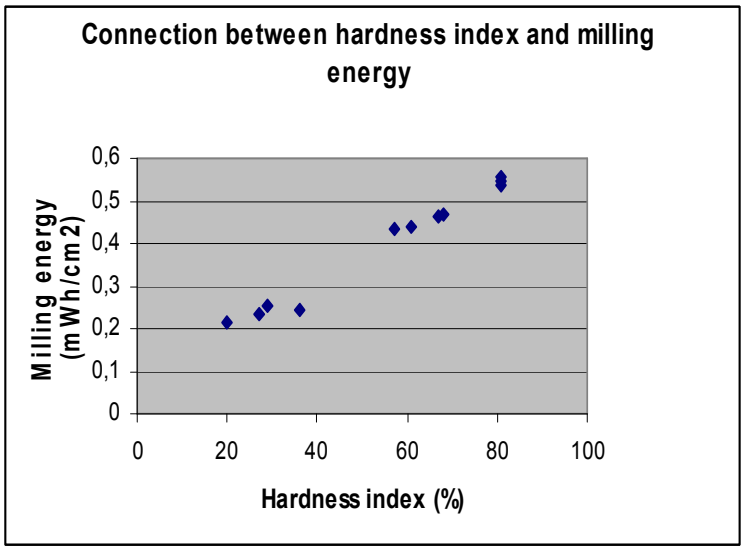

Figure 3. HI and milling energy(e_f) connection

At sample set “B” showed a very close correlation with the Hardness Index, measured by SKCS 4100, the water absorbance capacity of the flour (Figure 4.), made out of the crops, and got an acceptable correlation with the flours wet gluten content, and the alveographic deformation work as well.

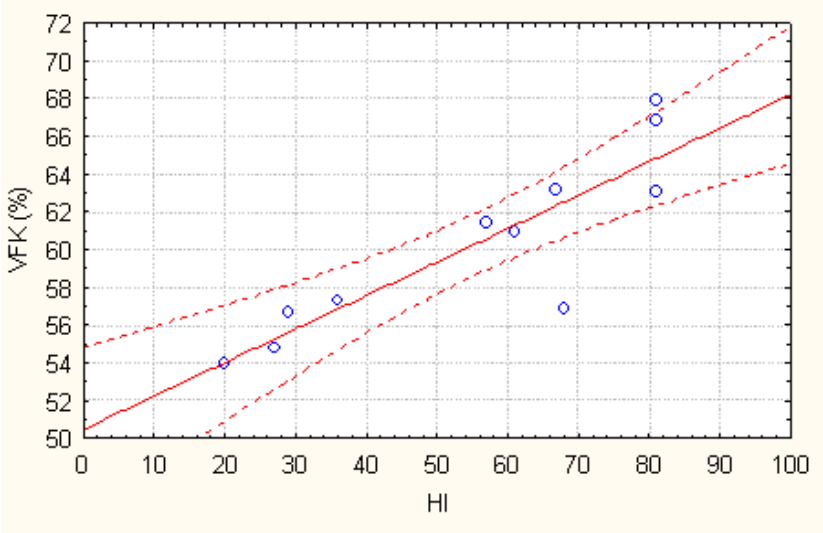

Figure 4. Connection between the water absorbance capacity and Hardness Index

The associations found in this study will help to better understanding the wheat grain and flour quality technological aspects as well as provide useful information to breeders to develop new, high quality hard a soft wheat varieties.

References

[1] Békési, F., A búza endospermium szerkezetének szerepe néhány minőségi búzát termelő országban, in szerk Bedő, Z.: *A jó minőségű, keményszemű búza nemesítése és termesztése*, (2001) 25-34.

[2] Greffeuille V., Abecassis J., Rousset M., Oury, Faye A., Bar L. 'Helgouac'h, C. Lullien-Pellerin V., Grain characterization and milling behaviour of near-isogenic lines differing by hardness. *Theor. And Applied Genetics* 114 (2006) 1-12.

[3] Gyimes, E., Neményi, M., Véha, A., Reológia és szemkeménység összefüggése őszi búzáknál In: Ötven éves az *Acta Agronomica Hungarica* Martonvásár (2002) 117-124.

[4] Gyimes, E., Összefüggés-vizsgálatok búzafajták szemtermésének agrofizikai tulajdonságai között, Doktori (PhD) értekezés Mosonmagyaróvár, *PhD thesis*, in Hungarian (2004)

[5] Martin J.M., Meyer F. D., Smidansky E.D., Wanjugi H., Blechl A.E., Giroux M.J., Complementation of the pina (null) allele with the wild type Pina sequence restores a soft phenotype in transgenic wheat. *Theor. And Applied Genetics* 113 (2006) 1563-1570.

[6] Szabó P. Balázs, A búza szemkeménységének a meghatározása a Lloyd 1000 R állományvizsgáló segítségével, *VII. Nemzetközi Élelmiszertudományi Konferencia* ISBN 963 482 676 2, Szeged (2006) 64-65.

[7] Véha, A., Gyimes E., Szemkeménység vizsgáló módszerek összehasonlítása őszi búzák esetében, *http://www.date.hu/kiadvany/tessedik/4/veha.pdf* (1999)