TWO METHODS TO DETERMINE THE KERNEL HARDNESS OF HUNGARIAN WINTER WHEAT VARIETIES

Véha Antal, Gyimes Ernő, Szabó P. Balázs
University of Szeged, Faculty of Engineering, Institute of Food Engineering
6725 Moszkvai krt. 5-7., Szeged, Hungary

Abstract

Wheat kernel texture differentiates cultivars of hard and soft wheat classes. The kernel hardness is a genetic factor (control by friabilin protein). The friabilin presents in high concentration in soft grain varieties and low concentration in hard grain varieties (Békési, 2001). Wheat kernel hardness determines quality, flour yield, flour particle-size, water absorption and other quality characteristics of cereals.

The aim of our research was to determine the kernel hardness. We used the Perten Single Kernel Characterization System (SKCS) 4100 device and Perten 3303 laboratory mill. Registered and widely used Hungarian wheat varieties were applied in the study. It was 11 different winter wheat varieties. As a result, we found correlation among the results.

Key words: Hungarian wheat varieties, kernel hardness,flour behaviour

INTRODUCTION

Cereals are essential mass sustaining products, covering significiant fraction of Earth's nutrition necessities. Besides human nourishment, cereal crops are used for forage and industrials needs as well (Tanács 2003). Cereals can be easily produced, can be grown anywhere, exertion facilities are large, and grain kernel can be siloed easily. It is typican for them that, their protein content is average or high, and provide high energy.

The most important corn in the ear is the wheat. It gives almost half of the produced amount of grain. It is grown in each of our nineteen counties. Best quality crop is produced in Békés-, Szolnok-,Hajdú-,Bács-,Pest counties and in Mezőföld and Kisalföld.

In the world's grain- , crops, grown and used for commercial purposes, are sorted in numerous classes. In case of durum and aestivum kernel, it contains the vernal and autumnal, the red and white just as soft and hard corns and all their combinations. In the last 20 years, the importance of endosperm classification (soft and hard wheat kernel) has grown bigger.

In the past 20 – 25 years , the interest in connection with commercial assortment, has grown considerably. Among from the previously mentioned emerges the significance of endosperm classification, rating according to the inner structure of the kernel. At wheat rating, postulating the inner structure of the kernel, it is extremely important that kernel hardness is the dependant of many properties in connection with the grain's technological quality. The system of endosperm classification of wheat means essential advantage for all participants of the wheat varieties, from the grower, through the dealer to the user (Békés 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. 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.

The kernel hardness has great effect on the baking properties of the resulting flour. Flour, which is made from hard wheat generally have a medium to high protein content and stronger gluten than flour, which is made from soft wheat. The friabilin protein complex determines the kernel hardness. Generally, 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. Hardness in wheat is largely controlled by genetic factors but it can be affected by the environment (Gyimes, 2004). The transgenic expression of wild type Pina sequence in the Pina null genotype gave soft grain with the characteristics of soft wheat including increased starch bound friabilin. Hardness is suggested to influence the adhesion forces between starch granules and protein matrix whereas vitreousness would rather be related to the endosperm microstructure (Greffeuille, et. al., 2006).

Kernel hardness reliant assortment, and the quality acceptance is essential for the companies, and this is why the identification of hardness that can be automate able if is so necessary.

Kernel hardness is an important measurable attribute of wheat that has been correlated to it's chemical and genetic make-up. The evaluation of wheat kernel hardness has been used in predictions of flour yield and gives early indication of baking performance (Pomeranz and Williams, 1990). Factors influencing kernel hardness include variety and environment, however the total variation in hardness has yet to be explained.

MATERIAL AND METHOD

In the course of our experiments, we examined 11 different wheat samples. 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.

Determining the kernel hardness by Perten SKCS 4100 equipment

During the measurement, the instrument (Figure 1.) measures the weight, size, moisture content and the hardness of the kernels. After determining 300 kernels unique properties it counts the average of the data gathered and counts standard deviation value and also, there is an opportunity to illustrate the measured results in column charts. The program provides an opportunity to see the last results after the following measurement. The measured results and their histograms can be printed if wished. The Hardness Index, produced by the machine as final results, is a physically non determined ratio, so in extremes cases the outcome can be zero or negative value.

Fig. 1. Perten Single Kernel Characterization System (SKCS) 4100 device

Valuation of grinding and performance

For the valuation of cutting and performance, we used a Perten 3303 laboratory mill (Figure 2.). We poured the sample into the mill's pharynx, than we started the discs and by pulling the bolt, we started the mincing. The measurement lasted for a minute, under which we recorded it's cycle time, the mincing mass stream and the electric energy. We measured the power consumption (W) and the energy use (Ws), needed for the mincing on a monophase Power Monitor PRO power meter instrument, and the mincing time with a stopwatch. We measured the weight of the grist, produced in the mincing, with an electric scale, and we carried out the sieve analysis. For the grist's sieve analysis we used a laboratory sieve row and a shaking machine. With the help of the specific milling labour (e_d – kWh/t) and the formed grists specific increase in surface area (Δa_d – cm^2/g), specific grinding energy demand (e_f – kWh/cm^2) can be calculated.

Fig. 2. Perten 3303 laboratory mill

Flour behaviour

We determine the samples flour characteristic. We measured the water absorbent capacity, the flour yield, the wet gluten and the alveograph values.

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.

RESULTS AND DISSCUSIONS

The sample average moisture content was 13.52% – Table 1..

Table 1.

Selected technology parameters of the entries in the study

Code	Wheat moisture cont. (%)	Flour yield (%)	Water Absorption Capacity (%)	Wet gluten (%)	Alveograph (P) (mm)	Alveograph (L) (mm)	P/L	Alveograph (W) ($x10^{-4}$ J)
B1	13.27	71.88	54.80	21.58	43.15	60.50	0.715	95.05
B2	13.86	71.79	57.30	27.48	60.75	77.00	0.790	179.85
B3	14.01	74.01	54.00	16.85	45.75	50.75	0.905	99.40
B4	14.00	68.33	56.60	25.30	55.90	68.75	0.815	128.85
B5	13.90	72.89	60.90	28.13	77.00	89.00	0.875	250.20
B6	13.85	71.28	61.40	22.88	105.01	42.75	2.460	187.35
B7	13.58	70.16	63.20	33.68	87.80	70.00	1.355	214.75
B8	13.37	70.96	67.90	31.70	93.15	59.50	1.565	176.80
B9	13.15	67.94	66.80	35.60	94.30	66.50	1.430	226.85
B10	12.82	70.46	63.00	29.68	102.55	53.00	1.960	225.20
B11	12.92	69.66	56.90	31.08	55.40	66.50	0.835	156.35

Table 2.

Results of Hardness Index and grinding energy

Code	SKCS 4100 (HI)	Perten mill Grinding energy (mWh/cm^2)
B1	27	0.235
B2	36	0.245
B3	20	0.215
B4	29	0.255
B5	61	0.440
B6	57	0.435
B7	67	0.465
B8	81	0.555
B9	81	0.545
B10	81	0.535
B11	68	0.470

The Hardness Index of the set of wheat defined by meter SKCS 4100 and the specific grinding energy demand. we can find a very close correlation (Figure 3.).

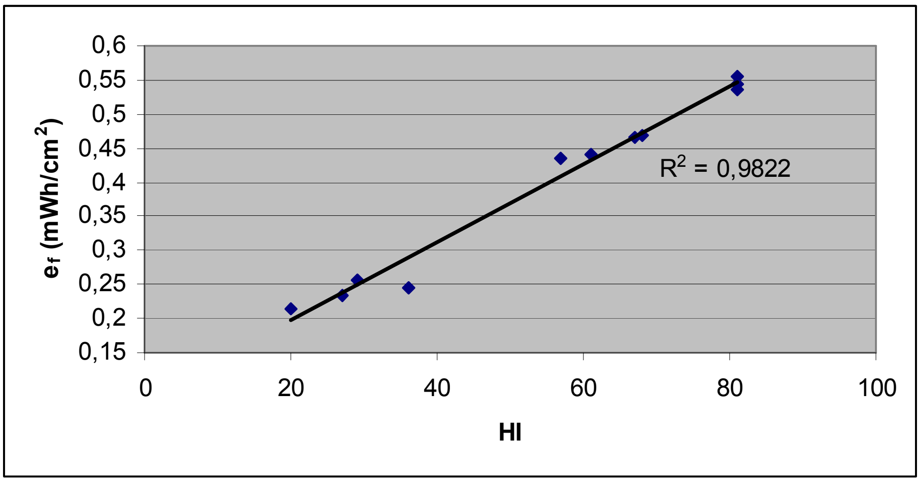

Fig. 3. Connection between specific grinding energy demand (e_f) and the Hardness Index

The sample set 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.

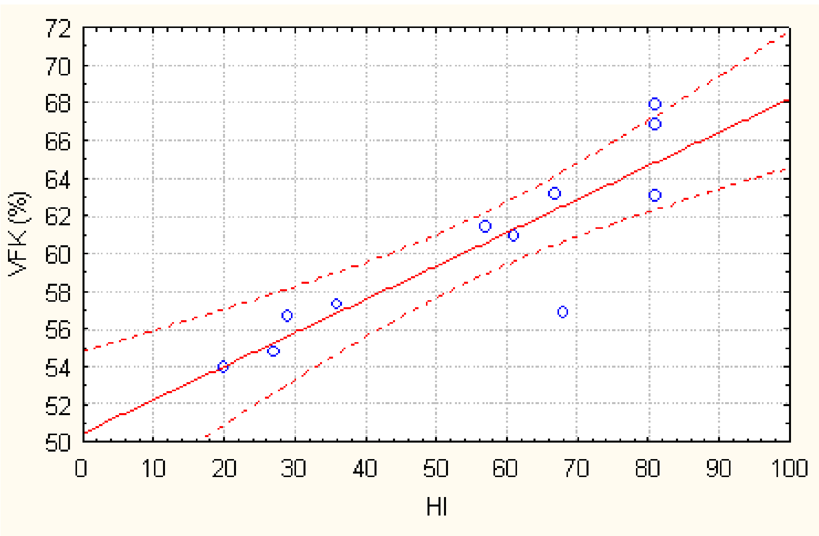

Fig. 4. Connection between the water absorbance capacity and Hardness Index

We further recommend defining the kernel's hardness categories based on the specific grinding energy demand development measured by disc mill.

This is a perspective measuring method, which is simple and fast because the measuring time is one minute. We can safely determine the hardness by finding the specific grinding energy demand.

CONCLUSIONS

A very strong correlation was found in the case of 11 different (4 soft and 7 hard)varieties with a 13.5 % moisture content in average between the Hardness Index measured by SKCS 4100 type equipment and the specific grinding energy demand measured by Perten 3303 disc type mill (R^2 = 0.982).

Correlation was found between Hardness Index determined by SKCS 4100 equipment and the examined flour parameters of the group of 11 different wheat varieties (4 soft and 7 hard) with an average moisture content of 13.5 %.

A strong correlation was found between the Hardness Index and the water absorbance capacity of the wheat flours (R^2 = 0.768) and a good correlation between the Hardness Index and the alveograph deformation work (R^2 = 0.598).

REFERENCES

1. Tanács L. (2003): Élelmiszerek növényi eredetű nyersanyagai. SZTE-SZÉF jegyzet. 6-22. p. (in Hungarian)
2. Békés. F. (2001): A búza endospermium szerkezetének szerepe néhány minőségi búzát termelő országban. CSIRO Division of Plant Industry. Canberra. Ausztrália. http://www.elitmag.hu/informaciok/szakcikk/endosper.htm (in Hungarian)
3. Pomeranz Y - Williams PC (1990): Wheat hardness: its genetic. structural and biochemical background. measurements and significance. In: Advances in Cereal Science and Technology. AACC. St. Paul. vol. X: 471-544
4. Greffeuille V. Abecassis J.. Rousset M. Oury. FFaye A. Bar L 'Helgouac'h. CLullien-Pellerin V. (2006): Grain characterization and milling behaviour of near-isogenic lines differing by hardness. Theor. Appl. Genet. 114:1-12.
5. Gyimes E. (2004): Összefüggés-vizsgálatok búzafajták szemtermésének agrofizikai tulajdonságai között. Doktori (PhD) értekezés Mosonmagyaróvár (PhD thesis. in Hungarian)