CONNECTION BETWEEN THE GRINDING ENERGY DEMAND AND THE WHEAT KERNEL HARNESS

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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. 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.

1. INTRODUCTION

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 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).

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.

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.

2. OBJECTIVES

The primary objective was to determine the nexus between the specific grinding energy demands (Perten 3303 laboratory mill), during the fracture of grains with the help of a disc grinder, and between the Hardness Index (Perten SKCS 4100).

3. MATERIALS AND METHODS

In the course of our experiments, we examined 11 different wheat samples. Out of these samples 4 sets can be classified as soft and 7 as hard grain structured. This numeral difference is due to that one of the aims of weed sublimation, is to sublimate hard wheat, and because of this, softer sets become insignificant.

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 code labelled.

3.1. 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.

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

3.2. 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.

Figure 2. Perten 3303 laboratory mill

For the evaluation we used STATISTICA for Windows 6. (StatSoft Inc. USA) and Excel table manager program.

4. RESULTS

We tested the samples, which had 13.52% moisture content – Table 1.

Table 1. Selected technology parameters of the entries in the study ("B" sample, 13.52% moisture content)

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

The Perten 3303 milling machines is a disc grinder, the grinding is between a serrulate moving disc and serrulate standing disc. The grinding controls with the distance of disc. There are six positions (0-6), we choose the 0,3,6 positions. There was different energy demand. The smallest position (0) has a biggest energy demand in the Perten 3303 milling machines; the 3 position has the middle and the 6 position has a least energy demand.

We made a trial test to determine that the laboratory mill is a good machine to separate (in connection with the kernel hardness) the wheat.

We used three samples (GK Mérő, GK Öthalom and Jubilejnaja 50) to determine energy demand. The Figure 3 shows that the three energy demands are different and it is significant. The e_d (kWh/t) is the specific grinding energy consumption, the „specific punch", which determine the physical behavior of materials. So the laboratory mill is a good device to sort the grain in two groups (soft, hard).

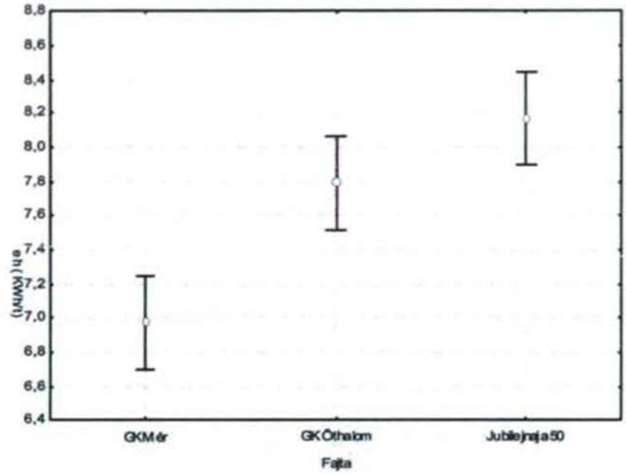

Figure 3. The Perten mill useful energy demand confidential interval

The Table 2. shows the results of the two machines. We measured the grinding energy with the "0" position.

Table 2. The results of Hardness Index and grinding energy ("B" sample, 13.52% moisture content)

Code	SKCS 4100 (HI)	Perten mill Grinding energy (mWh/cm^3)
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

5. DISCUSSION

In case of sample set "B" with the average moisture content of 13.5%, 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 4.). The significant level was 95%.

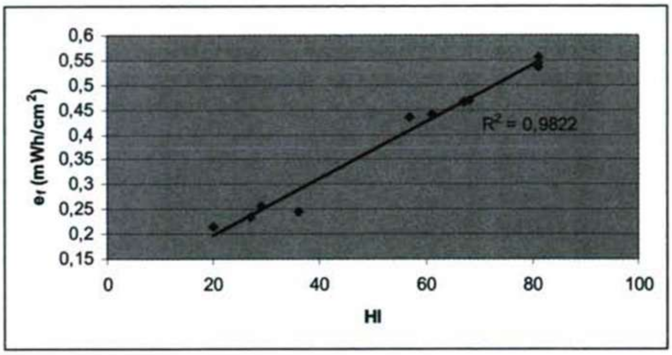

Figure 4. Connection between specific grinding energy demand (e_f) and the Hardness Index (set "B", moisture content: 13.52%)

6. 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). Two good define results were found, which can use in practice.

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