# FLOUR QUALITY AND WHEAT KERNEL HARDNESS CONNECTION

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## SUMMARY

Wheat kernel hardness is a very important inheritable parameter; it determines quality, flour yield, flour particle-size, water absorption and other quality characteristics. Besides, kernel hardness has great effect on the resulting flour's baking properties, too (Békési, 2001). The relationship between wheat protein content and kernel texture is usually positive and kernel texture (hardness) influences the grinding energy. Hard Wheat grains require more grinding energy ($e_g$) than Soft one (Véha, Gyimes 1999).
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-traits).
We used Perten SKCS 4100 to determine the kernel hardness, while the Perten 3303 mill was used to establish the grinding energy ($e_g$). Registered and widely used Hungarian wheat varieties (7 of HRWW and 4 of SRWW) were examined. Twin correlations were used to determine the relationship among the various traits. According to the results, there is a very strong correlation between the $e_g$ and the kernel hardness (r=0.991). The correlations between hardness index and the examined flour parameters were also significant. We found strong correlation between the $e_g$ and water absorption of the flour. The associations found in this study will help to better understand the technological aspects of wheat and flour quality as well as provide useful information the breeders to develop new, high quality hard or soft wheat varieties.

## 1. INTRODUCTION

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 that, which is made from soft one. The Hardness-locus on chromosome 5D is the main determinant of grain texture in bread wheat. Puroindoline-a (pin-a), puroindoline-b (pin-b) and Grain Softness Protein (GSP) genes are tightly linked at this locus and their products are the predominant components of friabilin, a 15 kD endosperm protein complex. The friabilin protein complex determines the kernel hardness. Generally, when the amount of the friabilin is high, the kernel hardness is soft and reverse (Ácsné, 2001). We can sort the kernel hardness in these two groups. Hardness in wheat is largely controlled by genetic factors but it can be affected by the environment, for example the weather (Gyimes, 2004). The transgenic expression of wild type Pin-a sequence in the Pin-a null genotype gave soft grain with the characteristics of soft wheat including stronger starch bound friabilin.

The results of Martin et al (2006) support the hypothesis that both wild type Pin genes need to be present for friabilin and soft grain formation. Vitreousness is also impact to evaluate the Middle-European wheat. The flour of hard wheat with high gluten content generally contains about 12.0-13.0 % (or more) crude protein under Middle-European conditions. The relationship between wheat protein content and kernel texture is usually positive and kernel texture influences the $e_g$ during milling. Hard textured wheat grains require more $e_g$ than those of soft ones. The aim of our research was to determine the relationships between kernel hardness and other technologically important traits in wheat varieties widely used in the Hungarian agriculture (Véha, 2005.)

## 2. MATERIALS AND METHODS

Eleven samples (registered wheat varieties) of bread with diverse technological qualities were used in this study. The samples were produced in the year of 2006 in Szeged, Hungary and were evaluated for various quality characteristics. Grain samples were taken during harvest (July) and were evaluated after 4 month storage period. The cleaned grain was milled by a Brabender Senior mill to determine the technological tests and establish the flour yield of the samples. Cleaned grain samples were used to identify the hardness index (HI) by SKCS-4100 instrument (Perten Inc.). The SKCS-4100 can complete a test in about 3 minutes, and simultaneously reports mean and standard deviation data for kernel weight, diameter, and moisture content, as well as the HI.

*Figure 1. SKCS 4100 instrument (Perten, Inc.)*

Grain samples then were ground by Perten 3303 to establish the $e_g$ using 1-phase output indicator interface.

*Figure 2. Perten 3303 disc mill (Perten, Inc.)*

Moisture content, wet gluten content, farinograph and alveograph tests were determined according to the EU-Standards. Farinograph gave information on the water absorption of the flour. Twin correlations were used to determine the relationship among the various traits, the significant level was 5 %.

## 3. RESULTS

The moisture, the milling, and other technological traits of the wheat samples, and hardness indexes and grinding energies were showed in Table 1.

*Table 1.: Selected parameters of the samples*

| Class | Entry code | Moisture (%) | Flour yield (%) | Water absorption capacity (ml) | Wet gluten (%) | Alveograph | | | | Hardness Index (HI %) | Grinding energy (mWh/cm$^2$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | P (mm) | L (mm) | P/L | W (J) | | |
| SOFT | II. | 13.27 | 71.88 | 54.8 | 21.58 | 42.40 | 65.50 | 0.65 | 102.06 | 27 | 0.235 |
| | III. | 13.86 | 71.79 | 57.3 | 27.48 | 63.49 | 93.75 | 0.68 | 204.54 | 36 | 0.245 |
| | VI. | 14.01 | 74.01 | 54.0 | 16.85 | 45.72 | 51.50 | 0.89 | 103.99 | 20 | 0.215 |
| | IX. | 14.00 | 68.33 | 56.6 | 25.30 | 49.99 | 67.30 | 0.75 | 123.80 | 29 | 0.255 |
| HARD | IV. | 13.90 | 72.89 | 60.9 | 28.13 | 88.25 | 70.00 | 1.26 | 251.35 | 61 | 0.440 |
| | VII. | 13.85 | 71.28 | 61.4 | 22.88 | 105.50 | 43.00 | 2.45 | 195.84 | 57 | 0.435 |
| | VIII. | 13.58 | 70.16 | 63.2 | 33.68 | 87.95 | 75.50 | 1.14 | 226.64 | 67 | 0.465 |
| | X. | 13.37 | 70.96 | 67.9 | 31.70 | 93.18 | 59.90 | 1.56 | 178.48 | 81 | 0.555 |
| | XI. | 13.15 | 67.94 | 66.8 | 35.60 | 100.30 | 47.00 | 2.16 | 189.91 | 81 | 0.545 |
| | XII. | 12.82 | 70.46 | 63.0 | 29.68 | 103.90 | 61.45 | 1.69 | 252.19 | 81 | 0.535 |
| | XIII. | 12.92 | 69.66 | 56.9 | 31.08 | 54.85 | 66.00 | 0.83 | 148.09 | 68 | 0.470 |

*Table 2.: Correlation matrix for the technological traits and grinding energy of wheat samples*

| | | Hardness Index HI (%) | Grinding energy (mWh/cm²) | Moisture (%) | Flour yield (%) | Water absorption capacity (ml) | Wet gluten (%) | Alveograph | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | P (mm) | L (mm) | P/L | W (J) |
| Hardness Index HI (%) | | 1 | | | | | | | | | |
| Grinding energy (mWh/cm²) | | 0.991 | 1 | | | | | | | | |
| Moisture (%) | | -0.637 | -0.600 | 1 | | | | | | | |
| Flour yield (%) | | -0.437 | -0.417 | 0.417 | 1 | | | | | | |
| Water absorption capacity (ml) | | 0.876 | 0.878 | -0.346 | -0.402 | 1 | | | | | |
| Wet gluten (%) | | 0.833 | 0.781 | -0.531 | -0.660 | 0.756 | 1 | | | | |
| ALVEO. | P (mm) | 0.816 | 0.826 | -0.244 | -0.224 | 0.873 | 0.560 | 1 | | | |
| | L (mm) | -0.217 | -0.320 | 0.141 | 0.096 | -0.260 | 0.171 | -0.325 | 1 | | |
| | P/L | 0.640 | 0.687 | -0.187 | -0.240 | 0.724 | 0.300 | 0.875 | -0.691 | 1 | |
| | W (J) | 0.675 | 0.634 | -0.151 | -0.055 | 0.623 | 0.582 | 0.808 | 0.209 | 0.468 | 1 |

The Perten-HI and grinding energy values were showed in Table 1. The SKCS 4100 compartmentalize the results in two groups. Under 50, the samples belong to Soft Wheat-, while samples 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 was a very strong correlation between the grinding energy and the kernel hardness (r=0.991). As Table 2 shows, the correlations among hardness index and the examined flour parameters were also significant (r=0.816-0.876). We found strong correlation between the $e_g$ and water absorption (r=0.878) of the flour. Hardness index – wet gluten (r=0.833) (Figure 3.), and hardness index – water absorption (r=0.876) (Figure 4.), hardness index – P value of alveograph (r=0.816) showed also positive correlations. We found correlation the water absorption and P value of alveograph (r=0.873).

The associations were found in this study would help to better understand the technological aspects of wheat and flour quality as well as provide useful information to breeders to develop new, high quality hard or soft wheat varieties.

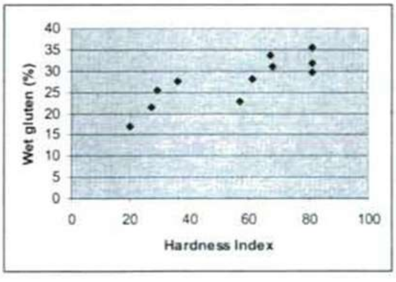


*Figure 3.: Relationship between hardness index and wet gluten*

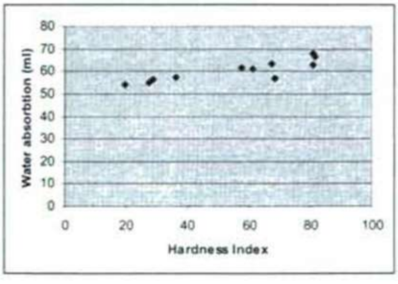


*Figure 4.: Relationship between hardness index and water absorption*

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