CONNECTIONS BETWEEN THE MECHANICAL PROPERTIES OF WHEAT

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ABSTRACT

The new method was developed, with which we can directly determine the breaking force and the breaking work, needed for snapping a kernel, and a parameter that gives information about the kernel flexibility (deformation modulus). To determine these values, we developed a measuring method, with which a single kernel can be measured. For this task we considered the measuring equipment Lloyd 1000 R to be appropriate, which is a precision stock measurer. We compared the results with outcomes from other kernel hardness measuring techniques (Perten SKCS 4100 machines). The significant level was 95%. The Lloyd instrument measures the pressure power on the kernel, due to the way that the pressure head has taken. The machine records data during the measurement, and draws the load – extension curve (with mm on the X axis and Newton on the Y axis). According to data we can instantly see the measure of power, which the kernel can not withstand and it snaps. Due to the 0 N and max. N values of the diagram and the path related to them, the max. power to snap a kernel can be determined, further called as snapping power and the snapping labour related to it, which is given by the field under the curve. From the power, path curve, the deformation modulus can be determined. The experiment was carried out on horizontally and vertically set crops as well. We tested two different sample sets, adjusted on different levels of moisture. Sample mark "A" was called "air-dry" (10.59% moisture content) and the "B" sample had 13.52 % moisture content. From the Hardness Index and the quasi static procedure we found that, with sample set mark "A",in case of "air-dry" set (moisture content 10,59%), the vertical experiments were more useful, in kernel hardness assortment, than experimenting in a horizontal position. We found that, the hardness index of the kernel with the average moisture of 10.6%, in vertical compression procedure, with the breaking work, has tight, and with the breaking force, has acceptable correlation. In case of sample set "B" (13.52% moisture content) Hardness Index has a close relationship with the deformation modulus of compression procedure in vertical procedure, with breaking force and the breaking work. Hardness Index has a close relationship with deformation modulus measured on horizontal compression procedure, and an acceptable relationship with breaking force. There has been a correlation between the Hardness Index measured by SKCS 4100 equipment and some of the mechanical characteristics of the wheat measured by Lloyd 1000R equipment when investigating a group of soft and hard- wheat varieties. A strong correlation was found between the Harness Index and the deformation modulus (R^2 = 0,813), between the Hardness Index and breaking force (R^2 = 0,882), and also a strong correlation between the Hardness Index and the breaking work (R^2 = 0,881) in the case of samples that have 13 % moisture content in average. A strong correlation was found in the case of samples that had 10.6 % moisture content in average between the Harness Index and the breaking work measured (in the vertical state) by the compression method (R^2 = 0,791), and a good correlation between the Hardness Index and the breaking force (R^2 = 0,690).

1. INTRODUCTION

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 sector, 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 if is so necessary (Bloch et al., 2001).

The primary objective was to find a measuring method for the kernel mechanical properties; especially deformation modulus, breaking force and work, measuring by compressional procedure, and to establish a link at corn sample sets between the mechanical properties, produced by the developed procedure, and the kernels Hardness Index.

2. MATERIALS AND METHODS

2.1. Materials

In the course of our experiments, we examined 23 different wheat samples. Out of these samples 10 sets can be classified as soft and 13 as hard grain structured. This numeral difference is due to that one of the aims of wheat breeding, is to selecting hard wheat, and because of this, softer sets become insignificant. We used Hungarian wheat as samples. The samples were provided by the Cereal Research Ltd, Szeged.

2.2. Method

Determining the kernel hardness by Lloyd 1000R Testing Machines

The instrument measures the pressure power on the kernel, due to the way that the pressure head has taken. The machine records data during the measurement, and draws the load – extension curve (with mm on the X axis and Newton on the Y axis).
According to data we can instantly see the measure of power, which the kernel can not withstand and it snaps. Due to the 0 N and max. N values of the diagram and the path related to them, the max. power to snap a kernel can be determined, further called as snapping power and the snapping labour related to it, which is given by the field under the curve. From the power, path curve, the deformation modulus can be determined. The experiment was carried out on horizontally and vertically set kernels as well.

Determining the kernel hardness by Perten SKCS 4100 equipment

During the measurement, the instrument 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. The SKCS 4100 compartmentalize the results in two groups. Fewer than 50 is soft grain, above 50 is hard grain (Gyimes, 2004).

3. RESULTS

From the Hardness Index and the quasi static procedure we found that, with sample set mark "A",in case of "air-dry" set (moisture content 10,59%), the vertical experiments were more useful, in kernel hardness assortment, than experimenting in a horizontal position. We found that, the hardness index of the kernel with the average moisture of 10.6%, in vertical compression procedure, with the breaking work, has tight, and with the breaking force, has acceptable correlation.

In case of sample set "B" (13.52% moisture content) Hardness Index has a close relationship with the deformation modulus (Figure 1.) of compression procedure in vertical procedure, with breaking force (Figure 2.) and the breaking work. Hardness Index has a close relationship with deformation modulus measured on horizontal compression procedure, and an acceptable relationship with breaking force.

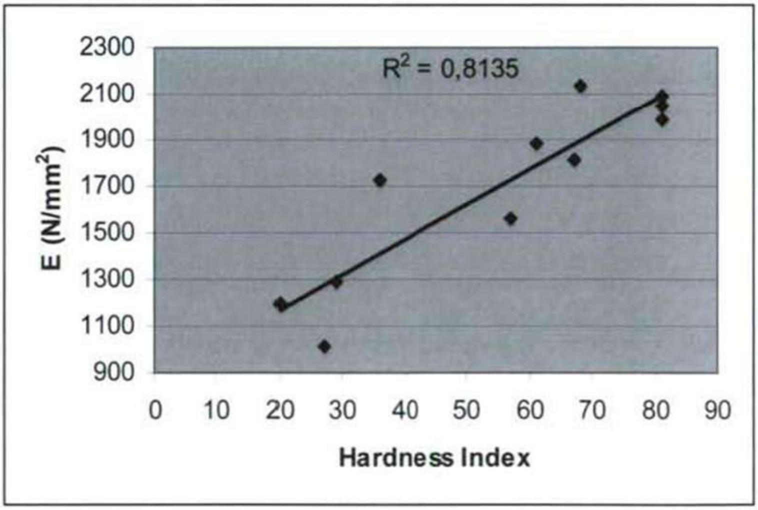

Figure 1. Connection between the deformation modulus (E) and the Hardness Index (set "B", vertical position, moisture content: 13.52%)

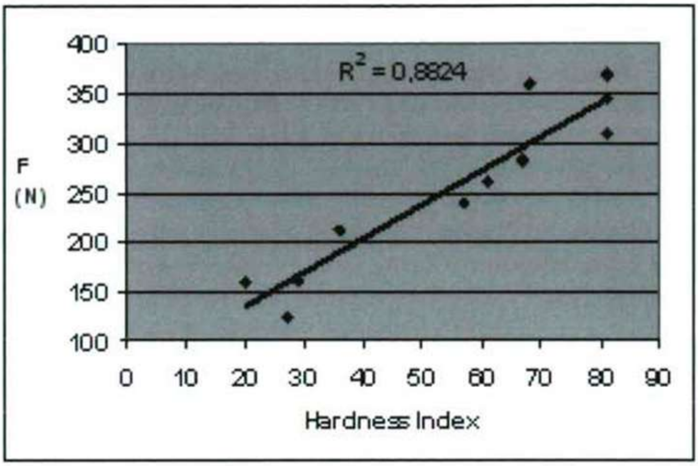

Figure 2. Connection between the breaking force (F) and the Hardness Index (set "B", vertical position, moisture content: 13.52%)

4. CONCLUSION

We worked out a measuring method, for measuring the mechanical properties of wheat species, by quasi static compression procedure. According to this method, after burnishing both ends of the wheat kernel, we measure the geometric properties and than put the kernels between the sheet of the precision pressing disks and the plane in vertical position. During the measurement, we record the load - extension curve, out of which the mechanic properties can be counted.

There has been a correlation between the Hardness Index measured by SKCS 4100 equipment and some of the mechanical characteristics of the wheat measured by Lloyd 1000R equipment when investigating a group of 23 different- 10 soft and 13 hard- wheat varieties.

In vertical position, a strong correlation was found between the Harness Index and the deformation modulus (R^2 = 0,813), between the Hardness Index and breaking force (R^2 = 0,882), and also a strong correlation between the Hardness Index and the breaking work (R^2 = 0,881) in the case of samples that have 13 % moisture content in average. In horizontal position the Hardness Index has a strong correlation with the deformation modulus.

A strong correlation was found in the case of samples that had 10.6 % moisture content in average between the Harness Index and the breaking work measured (in the vertical state) by the compression method (R^2 = 0,791), and a good correlation between the Hardness Index and the breaking force (R^2 = 0,690).

So there is a correlation between the dynamics method (Hardness Index) and the vertical measuring of static test (mechanical parameters). This static test is a good method to determine the kernel hardness.

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