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CHANGES IN HARDNESS AND THICKNESS OF WHEAT GRAIN AS A RESULT OF ITS MOISTENING

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A b s t r a c t. The influence of moistening and gentle drying of wheat grain on the variability of such significant features as its hardness and kernel thickness have been studied. For moistening, the wheat grain samples were placed between layers of blotting paper imbibed by distillate water. This process lasted for 6 h. Then, after removing excess water from the kernels, the samples were dried at room temperature. Measurements of hardness (hardness index) and thickness (diameter) of a single kernel were carried out using a single-kernel characterization system type SKCS 4100 on the dried grain and on the control material (non-moistened grain).

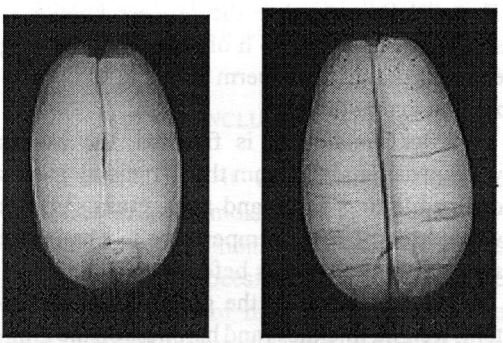
The results obtained clearly showed that after moistening a considerable decrease in the grain hardness index, by 10.6 [-] on the average, and rise in the kernel diameter, by 0.05 mm on the average, took place. The range of these changes was first of all related to the wheat cultivar. Rise in kernel thickness without a simultaneous increase in its weight shows that as a consequence of moistening, there could occur inner cracks of the endosperm causing an increase of its total volume and porosity. This kind of damage weakens the hardness of grain endosperm as well which what is reflected in the decrease of hardness index.

K e y w o r d s: wheat, kernel thickness and hardness, grain moistening, single kernel characteristics system

INTRODUCTION

Processes of moistening and then drying mature wheat grain begin already before harvest in field conditions [3]. Moistening process take place also during wheat grain tempering directly before milling to increase flour yield [1].

So far our studies [3,4,6,11,12] have proved that the visible effect of moistening is mechanical damage of grain endosperm. As shown in Photo 1, the resulting endosperm damage is mostly in the form of transverse cracks or narrow fissures. The maximum extent of endosperm cracks detected by the roentgenographic technique occurs already after 3 h of moistening of wheat grain. The mechanism of cracking is explained by the effect of faster imbibing of external endosperm layers, especially sub- and aleurone ones. In consequence, the increased stress causes failure of the deeper endosperm layers, which have not been moistened yet. So that the cracks pass transversely through the endosperm going up to the aleurone layer, but they do not disrupt it. It is obvious that this kind of damage can lead to the slackening and weakening of the grain structure as a whole.



a b

Photo. 1. Roentgenograms of the same wheat samples before (a) and after (b) moistening and drying.

At this moment, one can ask a question whether endosperm cracks that appeared as a result of grain moistening modify significant physical properties such as grain hardness and thickness? To answer this question, the present studies on the influence of moistening and gentle drying of wheat grain on the changes in grain hardness and thickness have been carried out. The results of evaluation of these changes conducted by means of the single kernel characterisation system [8] have been presented in this paper.

MATERIALS AND METHODS

Wheat grain sample of Polish cultivars grown on the experimental plots of the Agricultural University, Lublin, were taken for this study. The samples represented 4 cultivars of winter wheat (Alba, Begra, Nike and Rosa) and 4 cultivars spring wheat one (Alkora, Jota, Omega and Sigma).

Kernels of each sample were divided into two parts. One of them was control material (non-moistened). The other part was subjected to moistening by placing one layer of kernels between thick layers of blotting paper imbibed fully by distillate water. The moistening time was constant for all the grain samples and equal to 6 h. The choice of time period was based on the previous studies [5,10], which indicated that already after 12 h of moistening there is mechanical damage beside biochemical changes in the form of an increase in the α-amylase activity. These changes initiate the process known as sprouting. However, 6 h of moistening is long enough to case endosperm cracking to the maximum extent [12].

After moistening is finished, the excess water was removed from the kernels by means of dry blotting paper and then, grain samples were dried at room temperature to obtain the same grain moisture as before moistening.

Measurements of the grain moisture content, weight, thickness and hardness on the grain dried in this way and the control material were carried out using the single kernel characterization system of a SKCS 4100 type developed by the Perten Instruments AB [9]. This system automatically singles kernels and determines individual kernel weight, moisture, thickness and profiles of the crushing force. Then hardness index is calculated by means of an algorithm developed by the U.S. Department of Agriculture [7].

RESULTS AND DISCUSSION

Results from Table 1 show that differences in the moisture content between the control (non-moistened) and the moistened and then dried grain were slight and mostly did not exceed 0.1%. There were no significant differences observed in the kernel weight except in one cultivar, Begra.

These results allowed us to draw the conclusion both the control and the moistened grain taken to the thickness and hardness measurements had the same moisture content and the same kernel weight. So that two these features of wheat grain could not affect changes in grain hardness and thickness.

The influence of moistening and drying on the changes in kernel thickness and hardness index in relation to wheat cultivar is presented in Fig. 1. In each of the tested cultivars, grain

Table 1. Mean values of the moisture content and the kernel weight for the control and the moistened grain sample (after drying) in relation to wheat cultivar

Wheat cultivars	Moisture content (%)		Kernel weight (mg)	
	control	moistened	control	moistened
Alba	13.25	13.28	33.7	33.0
Begra	13.11	12.95	40.9*	43.0*
Nike	12.77	12.86	43.6	44.2
Rosa	13.02	13.08	42.7	43.0
Alkora	13.07*	12.78*	29.2	28.3
Jota	13.46	13.38	25.8	25.7
Omega	12.90*	12.72*	27.2	27.6
Sigma	13.05	13.08	35.6	34.9
Means	13.08*	13.05*	34.8	35.0
LSD for:				
Cultivars	0.12		1.7	
Means	0.04		NS	

* - significant differences between the control and the moistened grain.

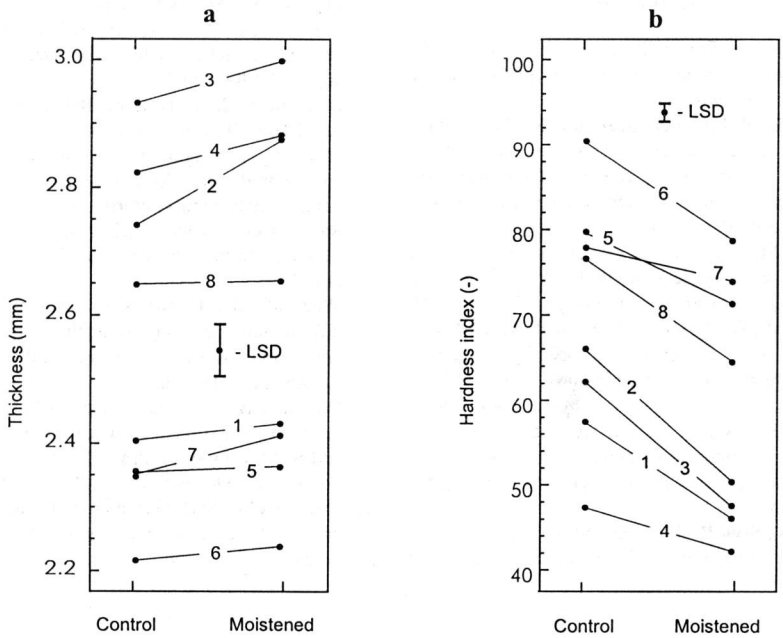


Fig. 1. Influence of moistening and drying on the changes in the thickness (a) and hardness (b) of single kernels in relation to wheat cultivar (winter form: 1 - Alba, 2 - Begra, 3 - Nike, 4 - Rosa; spring form: 5 - Alkora, 6 - Jota, 7 - Omega, 8 - Sigma).

moistening always caused a certain increase in kernel thickness, by 0.05 mm on the average. However, only the biggest increase observed for the cultivar Begra was statistically significant. It should be mentioned that the range of changes in the kernel volume relative to kernel thickness is three times bigger. So that these results can indicate a considerable increase in the total porosity of kernel structure due to endosperm cracks resulting from grain moistening. The above mentioned effects of cracks remain even if the moistened grain is gently dried up.

Even more visible effects of moistening were observed in the changes of kernel hardness. The results in Fig. 1 show that after moistening and drying, the hardness index decreased considerably, by over 10 units on the average. For all the tested cultivars, statistically significant decrease in the hardness index was observed.

To help to interpret these results, studies conducted by Bechtel *et al.* [2] should be mentioned here as they reported that drying of both soft and hard wheat at 28 and 40 °C did not cause any visible changes in grain hardness evaluated by the same index. It indicates that gentle drying used in our studies could not be the reason for such a considerable decrease in the hardness index. As was already been mentioned while interpreting changes in thickness, grain moistening caused cracking of the endosperm. In consequence, these endosperm cracks besides the rise in the not only weaken grain hardness but also cause a rise in endosperm porosity.

CONCLUSION

In conclusion it can be said that the processes of grain moistening and gentle drying, which are commonly used both in studies and agricultural processing practice to ensure the required level of moisture content in the grain, additionally cause structural changes in the grain endosperm in the form of mechanical damage and are reflected especially in the decrease of grain hardness.

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