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THE INFLUENCE OF DRYING TEMPERATURE AND MOISTURE OF CORN SEEDS PLANTED ON THEIR DAMAGE[1]

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ABSTRACT

Evaluation of harvest and postharvest treatment quality of the grains is affected by usage of appropriate equipment and technology. The grain damage depends on its physical and mechanical features. The corn planting has significant representation in European conditions, mainly for food industry purposes. In the work, we were focused on observing of the drying temperature´s impact on the micro-damage of the seeds. The solution of the issue described in the work is closely related to the preparation and solution of the education project KEGA 039SPU-4/2017, and a scientific research project VEGA 1/0718/17 „Study about the effect of technological parameters of the surface coating in agricultural and forestry techniques for qualitative parameters, safety and environmental acceptability“.

Introduction

The basic requirement for harvesting technology, post-harvest processing and storing is to preserve a natural biological quality of the grain to the possibly maximum extent, because it is important to know how the grain is stressed during these processes and what is happening with it (Burkhardt, 1974). Mechanical grain damage is one of the main causes of decrease in a biological value and loss of grain. It occurs in high altitude falls, during inadequate drying and also due to force interactions with working cells of harvesting and post-harvesting machines and transport equipment (Hlinica, 1988). The seeds undergo thermal stress during the drying process, which causes inner damage of the seed structure, lowering or total loss of germination and vitality in inappropriate thermal and time modes of drying (Židek, 2005). Physico-mechanical properties of seeds (Chowdhury, 2003) – grains are determined either genetically and also are influenced by a number of factors that act upon them during the growth and development of the parent plant (precipitation, nutrition, climatic conditions, soil type) during harvesting, post-harvest treatment, storing until they are planted (Petr, 2002;

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Angelovič, 1995; Jech, 1999; Arnoldus, 1978 and others). The surface layers of grains emit little moisture and air, have low thermal conductivity and are relatively well hydroscopic (Frančák, 2006). The moisture contained inside of the grains gets to the surface very slowly. Because of that, the surface layers are shrinking significantly faster and to a greater extent than the inner ones (Jech, 1999). The tension in the cover layers of the corn seeds can be of such high values, that even at a small stroke (later manipulation) the grain collapses to microparticles (Gunasekaran, 2005). The goal of the entry is to point out the impact of drying temperature on the seed quality of the food industry corn when it comes to micro-damage. A similar issue was dealt with by the authors (Gupta et al., 2001) with different technical equipment, while some of them were evaluating the seeds from the point of view of mechanical damage, as well.

The materials and methods

The experimental measuring was made on the corn grains, which was manually ground from the corn cobs (in order not to damage them by working operation - threshing), later the corn was moistened for desired humidity in the desiccator. Later it was dried inside of the laboratory dryer and the micro-damage was performed using to the CCD camera. The evaluation of the corn grain micro-damage was performed using a machine, which consists of two main parts. It is a machine which contains a video recording device, in our case, we used TV card Lifeview – Fly DVB-T Card Bus DUO (DVB-T Duo is a product which enables displaying both digital and analog signal, thanks to PCMCIA card), and a modified microscopic camera. The analog camera has 100x zoom (Fig. 1). We can connect it to a TV, but we can also use a TV card or a grabber and connect it directly to a PC. Integrated LED always allows optimal lighting of examined objects. The result of the research is in the figure number 2.

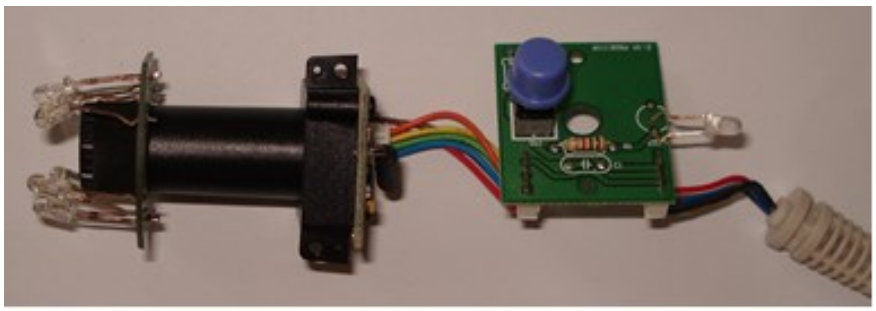

Figure. 1 The modified microscopic camera

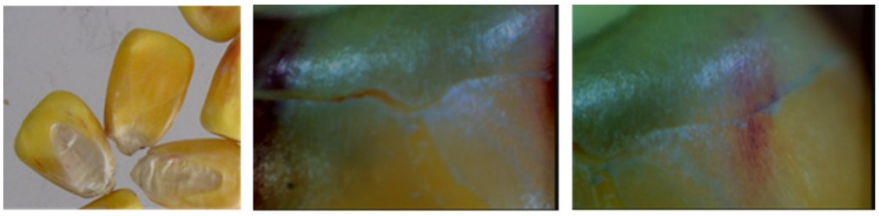

Figure. 2. The analysis of snaps made by CCD Camera was used when analysing the grain micro damages

The micro-damage evaluation itself was predated by drying and dry material temperature observation (Fig. 3). The equipment consisted of temperature sensors Pt1000, A/D converter MA-UNI with amplifier and a dataloger with measuring card iM 1610 from BMG Group company.

Figure. 3. View on the measuring equipment

Results and discussion

During the analysis of the post harvest grain treatment on a model line, we have discovered thanks to the HACCP method, which we modified and constructed for the process evaluation based on the work methodologics, that the most crucial part of the post harvest

treatment is the process of drying. Because of that, we have performed the laboratory measurements in order to find out how does the drying temperature and humidity influence the micro-damage, which is the most crucial factor for evaluating and lowering the quality parameters of observed grain material. We have compiled a working process, which helped us to evaluate the interaction of temperature and moisture on the grain material. The goal of the additional laboratory measurement was to determine the influence of drying temperature on the quality of food industry corn seeds, when it comes to inner quality/starch in dry matter and germination/ and the changes in micro-damage of the grains during the drying process. We have performed the drying for every new set of specimen by the temperatures of drying medium: 50°C, 70°C, 90°C, 120°C (Tab.1). The analysis of inner germination parameters and starch content inside the grains was made in a certified laboratory (company Belar-Group). From the measured values we can tell, that with rising drying air temperature (od 50°C to 120°C) micro-damage rises at all values of grain humidity (22% to 35%). At the same time we can assume, that with rising temperature of drying air and rising humidity of food industry corn seeds the germination decreases. At seed humidity of 20% and drying air temperature from 50°C to 120°C, the germination decreases from 93% to value of 7%. At the same temperature of drying air 35% of grain humidity, germination rate decreases from 10 to 1%.

Table 1.
Influence of the grain moisture and the drying temperature on the parameters analyzed

Grain moisture (%)	Air temperature (°C)	Parametre, Parameters	
		Microdamage (%)	Germinability (%)
20	50	14	93
	70	20	74
	90	27	39
	120	39	7
25	50	21	90
	70	26	68
	90	33	33
	120	41	5
30	50	33	47
	70	29	35
	90	38	24
	120	44	3
35	50	41	10
	70	34	5
	90	48	2
	120	56	1

The evaluation of the micro-damage was performed using a method on laboratory equipment, which was constructed in order to analyse the micro-damage. Graphical results of evaluation of micro-damage according to the drying temperature and corngrain humidity are listed in the figure 4 and 5.

In the image 4 a dependency of micro-damage and the drying medium temperature is depicted. From the course of dependence we can assume, that with increasing the drying tempereature (from 50ºC to 120ºC) the micro-damage rate is increased. While the humidity of the grains is 20% from the value of 14% to the value of 39% and when the humidity is 35% from the value of 41% to a value of 56%.

Figure 5 depicts the course of micro-damage dependency on the humidity of the dried grain. As it can be seen, increasing of grain humidity also increases the micro-damage and the highest damage is by the highest drying temperature, 120 degree celsius, when it reaches values between 39% and 56%.

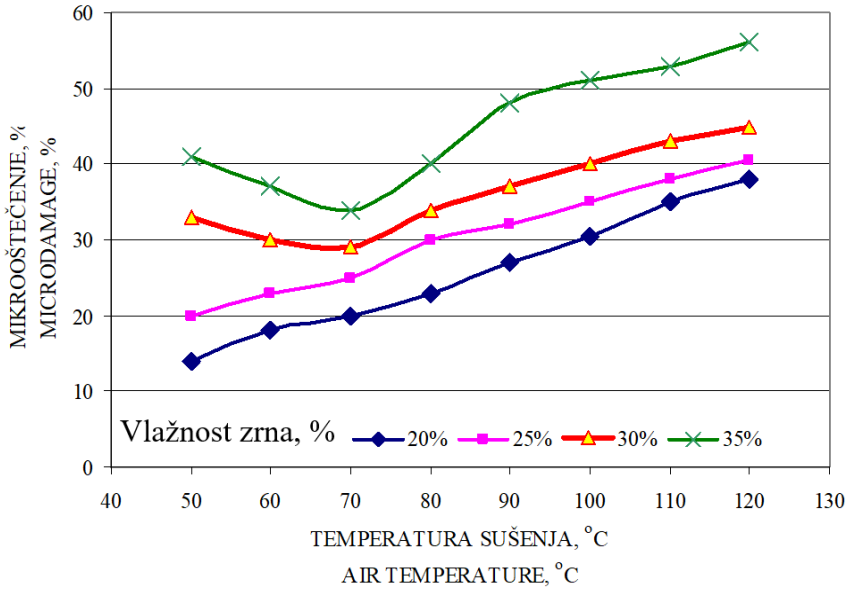

Figure 4. Dependence of grain micro-damage on the drying temperature and various moistures of grains analyzed

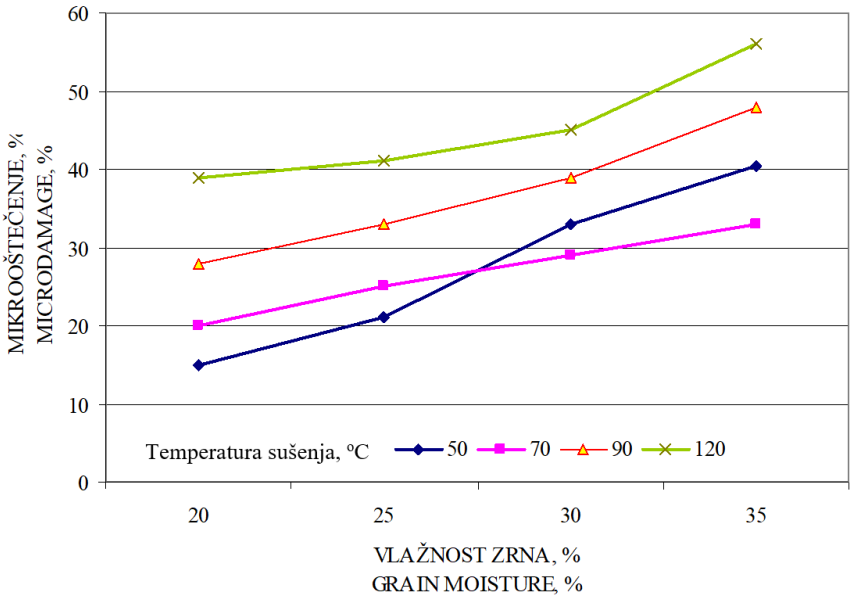

Figure 5. Dependence of the grain micro-damage of edible corn on the moisture and on various drying temperatures of grains analyzed

Conclusion

The results of laboratory measurements confirmed, that with increasing drying temperature and humidity of dried grains, the rate of micro-damage of food industry corn also increases. With increasing drying tempereature the germination of the seeds of food industry corn decreases and the seeds with higher humidity than 30% are not recommedned to dry, because of the fact that they do not meet the required standard for germination of food industry corn. The impact of drying temperature in between 50 and 120ºC on the starch volume inside the grains was proved, so it is possible to say, that the drying process does not influence this parameter. These important facts should be taken into account in management of post-harvest treatment. Thus, we can sum up the laboratory measurements like this: (1) drying the grains of food industry corn by higher temperature than 80ºC is not recommended because it does not meet quality standards of STN 46 1100-8 for germination parameter. (2) gathering and thrashing food industry corn by humidity higher than 30% is not recommended, because of increased exposition during the drying and not meeting the required germination even by using lower drying temperatures.

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WPŁYW TEMPERATURY SUSZENIA I WILGOTNOŚCI NASION KUKURYDZY NA ICH USZKODZENIE

Streszczenie. Ocena jakości zabiegów związanych ze zbiorem i po zakończeniu zbioru nasion zależy od użycia odpowiedniego sprzętu i technologii. Na uszkodzenie ziarna wpływ mają jego cechy fizyczne i mechaniczne. Uprawa kukurydzy jest popularna w warunkach europejskich, głównie dla przemysłu spożywczego. W tej pracy skupiliśmy się na obserwacji wpływu temperatury suszenia na mikro uszkodzenia ziaren. Rozwiązanie tego problemu opisanego w pracy jest ściśle związane z przygotowaniem i wykonaniem projektu edukacyjnego KEGA 039SPU-4/2017 oraz projektu naukowo-badawczego VEGA 1/0718/17 „Badania nad wpływem parametrów technologicznych powlekania powierzchniowego w technikach rolniczych i leśnych dla celów zgodności jakościowej parametrów, bezpieczeństwa i środowiska.

Słowa kluczowe: zabiegi pozbiorcze, mikro uzkodzenia, normy HACCP, kukurydza spożywcza

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