EFFECT OF THE DRYING MEDIUM TEMPERATURE AND GRAIN MOISTURE CONTENT ON THE DAMAGE OF THE FOOD MAIZE GRAINS

UTICAJ TEMPERATURE MEDIA ZA SUŠENJE I VLAŽNOSTI ZRNA NA OŠTEĆENJE KUKURUZA ŠEĆERCA

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SUMMARY

Working operation „drying“ can be considered as a critical point within the postharvest grain processing due to its effect on the quality of the final product. Therefore it is very important to strictly follow the regime of the drying technology, especially the temperature of the drying medium (drying air).

Grain damage can be considered as a most important factor among the effects of machinery and technologies used in postharvest grain processing. Susceptibility of grains to damage is given by grain properties of different grain crop sorts. It is very important to study grain damage especially in the case of food maize, which is grown in large scale areas. In the paper we have focused our attention on the effect of the drying temperature on the micro-damage.

The results obtained during laboratory experiments have allowed us to formulate the following recommendations: food maize grain should not be dried on temperatures higher than 80° C since they do not meet the qualitative requirements of the standard STN 46 1100-8 concerning the germination parameters; food maize grain with the grain moisture content higher than 30% should not be harvested and thrashed due to increased heat effect exposition during drying process and failure to reach the requested grain germination requirements even at low drying temperatures.

Key words: management post-harvest grains treatment, microdamage, HACCP, food corn

1. INTRODUCTION

Postharvest grain processing plays an important role in cropping system and also from the point of the long term grain quality preservation. In grain drying process the grains are heat stressed. It causes internal grain structure damage, decreasing or even total loss of the germination and germinative quality as a result of the unsuitable thermal and temporal drying regimes (Židek, 2005).

Cover layers of the grains poorly transmit moisture and air, they have low thermal conductivity and they are quite good hydroscopic. The moisture, contained inside the grain,
reaches the grain surface very slowly. Due to this fact the surface layers are contracting much more fast than the internal part of the grain. Strain in the surface layers of the maize grain can be such high then even slight impact can cause the grain destruction during grain manipulation (Gunasekaran, 2005). The aim of the paper is to point out the effect of the drying temperature on the food maize grain quality, especially from the point of the micro-damage. Similar problems have been studied by (Hez, 1984; Gupta et al, 2001; Lin et al, 1999; Brkić et al, 2006, 2007; Prvulović et al, 2007;) but the have used different equipment while also evaluating the grain seeds from the point of mechanical damage.

2. MATERIALS AND METHODS

Experiments have been conducted on the maize grains, which have been manually separated from the cobs (to avoid damage during mechanical threshing), then the grains have been moistened in the exicator on the requested grain moisture content. Subsequently the grains have been dried in the laboratory drier and the micro-damage has been studied using CCD camera.

Grain drying and temperature monitoring of the dried grain material was the first step. The apparatus we used consisted of the temperature sensor Pt100, A/D transducer MA-UNI with amplifier and datalogger with the measuring card iM 160 from the company BMG Group.

To evaluate grain micro-damage we used the apparatus consisting of two main components. The first one is the device which allowed us to record video sequences. In our case we have used TV Card Lifeview – Fly DVB-T Card Bus DUO. Note: DVB-T DUO displays digital and analogue TV signal by means of PCMCIA card. We also used a microscopic camera, which was adapted to meet our requirements. The analogue camera allows centuplicate magnification. (Fig.1). It can be connected to a TV set, but by using TV card, or grabber it can be connected directly to a computer. The in-built LED provides optimal lighting of the objects which are studied. The result of the scanning is given in Fig. 2.

Sl. 1. Mikroskopska kamera (prerađena)
Fig. 1. The modified microscopic camera
Lonely ratings micro defect preceded drying and monitoring temperatures drying material (picture 3). Equipment is consisted from scanner temperatures Pt1000, and/D converter I-UNI from carrier repeater and datalogger with measuring card iM 1610 from BMG Group company.

3. RESULTS AND DISCUSSION

The analysis of the process of the post-harvest grain processing we have conducted on the model line. By using of the modified HACCP method we have found out that the drying process can be considered as a most crucial element of the post-harvest grain processing line. Therefore we have done laboratory measuring with the aim to find out how grain temperature and grain moisture content effect the formation of the grain micro-damage. In general grain micro-damage can be considered as key factor used for the evaluation of the grain quality and causing the grain quality decreasing. We have prepared the procedure for the evaluation of the mutual effect of the drying temperature and grain moisture content on the grain material.

The aim of the supplementary laboratory measuring was to find out the effect of the drying temperature on the quality of the food maize grains from the point of internal quality.
(content of the starch in the dry matter and germination) and changes of the grain micro-damages caused by drying process.

The drying was provided for each new set of samples at the temperature of the drying medium: 50°C, 70°C, 90°C, 120°C. (Table 1). The analysis of the internal parameters of the germination and starch content has been provided in the certified laboratory of the Belar Group Company. The obtained results have confirmed that the increasing of the drying air temperature (from 50°C to 120°C) causes the increase of the grain micro-damage for all values of the grain moisture content (from 22 % to 35 %). In the same time it is possible to state that the increasing of the drying air temperature and maize grain moisture content results in decrease of the grain germination. For maize grain moisture content 20% and drying air temperature in the range 50 – 120°C values of germination have decreased from the 93 % to 7 %. For the same temperature of the drying air and maize grain moisture content 35 % the germination has decreased from 10 % to 1%.

Tab. 1. Uticaj vlažnosti zrna kukuruza i temperature sušenja na analizirane parametre
Tab. 1. Influence of grain moisture and drying temperature on the parameters analyzed

<table>
<thead>
<tr>
<th>Grain moisture, %</th>
<th>Air temperature, °C</th>
<th>Microdamage, %</th>
<th>Germinability, %</th>
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The evaluation of the micro-damage was performed on the laboratory apparatus specially designed for the purpose of micro-damage analysis. The results of evaluation of the effects of drying air temperature and maize grain moisture content on grain micro-damage are given in Fig. 4-5.
In Fig. 4 is shown the effect of drying air temperature on grain micro-damage. It can be seen that the increase of drying air temperature from 50 to 120°C also increased the grain micro-damage. For the 20% grain moisture content, the grain micro-damage increased from 14 % to 39 %, but at the 35 % grain moisture content, the grain micro-damage was increased from 41 % to 56 %. This implies that the grains with higher moisture content are more sensitive to acting loads and stress.

In Fig. 5 the effect of grain moisture content on the grain micro-damage is shown. Obviously, the increase of grain moisture content results in higher grain micro-damage and the highest grain micro-damage was recorded at the highest value of the drying temperature 120%, when it reached the values from 39% to 56%.

4. CONCLUSION

The results of laboratory experiments have confirmed that the increase the air drying temperature and grain moisture content results in increase of food grain micro-damage. The increase of drying temperature caused the decrease of germination of the food maize grain. We do not recommend drying of maize grains with the grain moisture content higher than 30% as in such cases food maize germination standards cannot be met.

The effect of the air drying temperature within the range 50-120°C on the starch content in the grains could not be confirmed. We can therefore state that the drying process has no effect on this parameter.

The above mentioned facts should be observed during management of the grain post harvest processing. The results obtained during laboratory experiments allowed us to formulate the following recommendations:

- we do not recommend drying of food maize grain at temperatures higher than 80°C as the qualitative requirements of the standard STN 46 1100-8 concerning the germination parameters cannot be met,
- we do not recommend harvesting and threshing of food maize grain with grain moisture content higher than 30% due to increased heat effect during drying process and failure to reach the requested grain germination requirements even when the low drying temperature is used.

5. REFERENCES

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SAŽETAK

Tehnološka operacija sušenja kao deo posleubirajuće tehnologije pripreme semena predstavlja kritičnu tačku sa stanovišta kvaliteta dobijenog proizvoda. Jako je bitno da se striktno pridržava precizna tehnologija sušenja, što se naročito odnosi na optimalnu temperaturu medija kojim se izvodi sušenje.


Rezultati dobijeni u laboratorijskim eksperimentima omogućili su formulisanje sledećih preporuka: ne preporučuje se sušenje zrna kukuruza za ishranu na temperaturama iznad 80°C, jer to ne zadovoljava zahteve kvaliteta u vezi sa parametrima klijanja, propisane standardom STN 46 1100-8; takođe se ne preporučuju žetva i vršidba kukuruza za ishranu čija vlažnost zrna prelazi 30%, radi povećane izloženosti toplotnom dejstvu u toku procesa sušenja i nemogućnosti dostizanja zahteva u pogledu klijanja zrna čak i na nižim temperaturama sušenja.

Ključne reči: posleubirajuća dorada zrna, mikrooštećenje, HACCP, kukuruz šećerc