Impact of changes in climate conditions on the technological quality of wheat

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Abstract
The aim of this paper was to describe the impact of changes in climate conditions on the technological quality of wheat. Average wheat flour samples have been tested by Standard methods for the determination of technological wheat quality with extensograph, farinograph, amyllograph and alveograph. Obtained results showed that in period of ten years climate conditions caused differences in wheat technological quality.

Key words: wheat, technological quality, climate conditions

Introduction
Wheat is grown under a wide range of environmental conditions where climatic factors such as temperature and moisture combined with agronomic inputs such as fertilizer exert diverse effects on plant growth and metabolism. The manifestation of those effects in the developing kernel impacts the value of the crop by influencing yield, grain characteristics and flour quality (Altenbach et al., 2003). Also, the effect of an environmental factor depends on the developmental stage of the plant (Tibold et al., 2006). Grain quality is a function of grain composition (Tibold et al., 2000), and quality vary considerably as a result of environmental conditions during grain-fill (Dupont and Altenbach, 2003).

The aim of this research was to define possible consequences of changes in climate conditions on the technological quality of wheat.

Material and methods
Analyzed samples originated from ten wheat production years: 2001-2010, which were characterized by very different climate conditions. The samples were collected from numerous locations of Serbia and their parts used to form average year samples.

Average wheat flour samples have been tested by Standard methods for the determination of technological wheat quality: rheological examinations with extensograph, farinograph, amyllograph and alveograph (ICC Standard No. 114/1, ICC Standard No. 115/1, ICC Standard No. 126/1 and ICC Standard No. 121). Laboratory test baking method was applied according to Torbica et al (2007).

Results and discussion
We considered the impact of changes in climatic conditions in the territory of Serbia on the technological quality of wheat *Triticum aestivum* during the past ten years. Generally, in this period altered technological wheat quality can be considered depending on extremely hot days and exceptionally large amounts of rainfall, as well as their indirect consequences. High temperatures in the period from May to July, as well as during the harvest, have been notified in 2004 and 2009 years. Extremely large amounts of rainfall and harvest interrupted by rain were characteristic of the 2005, 2009 and 2010 years.
Development of field molds and insects are the indirect influence of climatic conditions. In Serbia, as well as the most Mediterranean countries, during the past ten years the intensive attacks of wheat bugs have been typical. Especially, in Serbia it was characteristic for 2004 year. Direct and indirect climate impacts have contributed to the trade and technological wheat quality in Serbia. The good trade quality did not mean the good technological wheat quality and vice versa. Until 2010, according to standard parameters, wheat possessed good to excellent trade quality, but poor and problematic technological quality. However, the wheat from harvest in 2010 was estimated on the basis of standard parameters as poor quality - trade and technological.

The average values of usual technological quality parameters of dough made from wheat flour, showed the trend of reducing during the last decade. Also, the same parameters were characterized by very broad ranges, which indicate uneven technological quality of wheat in Serbia. Figures 1, 2 and 4 show the average values of extensogram (Fig. 1), farinogram (Fig. 2) and amylogram (Fig. 4) parameters in the period from 2001 to 2010 year. Average energy values obtained by extensograph are generally low (except in 2006) from the standpoint of the required energy values for bread making. It was found that during that period, low energy values were not a consequence of small amounts of protein and Zeleny sedimentation values as a measure of their quality (Mastilović et al., 2005; Torbica et al., 2010b). Also, the average parameters values of farinogram during the same period (Fig. 2) show that the average value of the water absorption was almost unchanged, while in the last five years the average values of the degree of softening were increased. On this way the flour quality number gradually reduced, which ranked flours in the lower categories within the quality group (A1 is the best, C2 is the worst).

Based on the standard interpretation of extensogram and farinogram parameters values could be concluded that bread making is impossible or that bread quality will be unacceptable. However, the practice denied it. Moreover, in the year 2004 the flour samples which could not register energy at extensogram could be divided into two groups by bread making properties. The first group of flour samples had destroyed proteins structure as a result of attacks of wheat bugs, and even though with additives could not possible to produce bread. Another group of flour samples was due to heat stress had increase in amount of gliadin in relation to common values. Altered ratio of gliadin and glutenin caused extremely increased extensibility of dough, but with the addition of additives to these flour samples producing of bread was possible (Torbica et al., 2007). Based on experience of examined time period can be concluded that the energy values of the extensogram can not be interpreted as in previous decades in the evaluation of technological wheat quality. An example of similar bread making properties of two flour samples with quite different energy values on extensogram, work of deformation on alveogram and similar values of maximum viscosity at amylogram is shown in Figure 3.

The values of maximum viscosity measured at amylograf show decreasing trend (Fig. 4) and it can not be interpreted as in previous decades in the estimation of technological wheat quality like as in the case of energy on extensogram. It was found that in the examined time period low values of maximum viscosity at amylogram were caused by two different impacts of climate conditions. Those impacts were heat stress (which caused a disturbance in the synthesis of wheat starch) (Torbica et al., 2010a) and prolonged heavy rainfall (Mastilović et al., 2005; Torbica et al., 2010b).
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Figure 2. Values of farinogram parameters of average flour samples measured by farinograph

Figure 3(a,b). Photos of bread samples (a) from dough with $E=28 \text{ cm}^2$, $W=115 \times 10^{-4} \text{ J}$ and 315 AU and (b) from dough with $E=56 \text{ cm}^2$, $W=159 \times 10^{-4} \text{ J}$ and 285 AU

Figure 4. Values of amylogram parameters of average flour samples measured by amylograph

An example of similar bread making properties of two flour samples with quite different values of the maximum viscosity at amylogram is shown in Figure 5. The different values of the maximum viscosity of these flour samples were caused by the difference in the amount of rainfall at their grown wheat areas (a - wheat from localities with high rainfall; b - wheat with localities with low rainfall). Bread produced from flour sample with a low value of the maximum viscosity (155 AU) in relation to the bread produced from flour sample with a higher value of maximum viscosity (370 AU) had a slightly lower specific volume (6.20 in comparison to 6.56 ml/g), slightly better elasticity, darker color of the crust and finer pores.
Conclusion

Technological quality of wheat was under strong influence by changes in climatic conditions at territory of Serbia in last decade. There are more than one climatic changes which caused the same effect on processing wheat quality, and on contrary there are different effects on wheat quality which are caused by the same climatic condition. Based on obtained results of analysis in examined time period, it is clear that values of the usual wheat quality parameters can not be interpreted as in previous decades in the predicting of technological wheat quality.

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References


ICC Standard No. 114/1: Method for Using the Brabender Extensograph
ICC Standard No. 115/1: Method for Using the Brabender Farinograph
ICC Standard No. 121: Method for Using the Chopin Alveograph
ICC Standard No. 126/1: Method for Using the Brabender Amylograph


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