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# Detection of qualitative changes of ecologically cultivated wheat with different intensity of *Fusarium* spp. contamination using rheological system Mixolab

Ivana Capouchová<sup>1\*</sup>, Ludmila Papoušková<sup>2</sup>, Petr Konvalina<sup>3</sup>, Dagmar Janovská<sup>2</sup>, Monika Zrcková<sup>1</sup>

<sup>1</sup> Czech University of Life Sciences, Prague 6 – Suchdol, Czech Republic

 $^{2}$  Crop Research Institute in Prague, Prague 6 – Ruzyně, Czech Republic,

<sup>3</sup> University of South Bohemia Faculty of Agriculture, České Budějovice, Czech Republic,

The impact of *Fusarium* spp. contamination on baking quality of common wheat (variety Bohemia) from organic farming system was monitored by rheological system Mixolab. The mycotoxin deoxynivalenol (DON) content and standard technological quality characteristics were measured, too. Considerably worse technological parameters were determined in variant with higher *Fusarium* spp. contamination, evoked by the artificial inoculation of flowering ears. Simultaneously, increased intensity of *Fusarium* spp. contamination evidently worsened rheological quality and its negative effect on protein and starch part of the grain was obvious from the Mixolab characteristics.

Keywords: wheat, Fusarium spp., technological quality, Mixolab

#### 1 Introduction

*Fusarium* head blight (FHB) is a fungal disease of small grain cereals caused by pathogen fungi *Fusarium* spp. and has bacome a serious danger to the worldwide grain industry. *Fusarium* spp. fungi destroys starch granules, storage proteins and cell walls, and subsequently affects the dough properties (Dexter et al., 1997). FHB also leads to the accumulation of mycotoxins, which are produced during the fungal infection process. Despite the contradictory reports in the literature concerning the close correlations between FHB and mycotoxins content, it is accepted that overall, accumulation of mycotoxins in kernel also would require successful infection and colonization stages of host (Smith et al., 2004). Moreover, in the case of very strong infectious pressure, induced by artificial inoculation, it is possible to presume, that also content of mycotoxins will be high.

The negative effects of FHB on basic baking quality parameters of wheat were already found (Gärtner et al., 2008), but knowledge of the rheological properties of flour is fundamental for specifying baking parameters, too. Mixolab system enables to evaluate physical dough properties such as dough stability or weakening and starch characteristics in one measurement. By this time there are not many studies about a capability of Mixolab system to define rheological parameters of wheat with various grade of fungi infestation.

### 2 Material and Methods

Exact field plot trial with winter common wheat variety Bohemia was conducted in organic farming system during the years 2012–2013 on the experimental station of the Department of Crop Production CULS Prague in Uhříněves. This station is located at 295 m above sea level, average annual temperature is 8.4 °C, average sum of precipitation 575 mm (Mičák, 2013).

Harvested grain samples were used for evaluation of the effect of FHB infestation on deoxynivalenol content in grain – besides the variant with natural FHB contamination,

<sup>\*</sup> Correspondence: Ivana Capouchová,CSc., Czech University of LIfe Sciences Prague, Kamýcká 129, 165 21 Prague 6 – Suchdol, Czech Republic. E-mail: capouchova@af.czu.cz

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variant with artificial inoculation (isolates of F. culmorum and F. graminearum) was used, too.

Mycotoxin DON determination was made according the method, described by Džuman et al. (2014).

Standard technological quality parameters of grain and rheological parameters of dough were also evaluated. Within the frame of baking quality, crude protein content (CP) according to the Kjeldahl method (EN ISO 20483; ICC-Standard No. 105/2), wet gluten content (WG) in grain dry matter and Gluten Index (GI) using the apparatus Glutomatic (ISO 5531), falling number (FN) – ISO 3093, Zeleny sedimentation index (ZS) – ISO 5529, volume weight (VW) – ISO 7071-2 and TKW (Thousand kernels weight) were determined.

Rheological characteristics were determined by apparatus Mixolab (Chopin), according to the Mixolab protocol (Mixolab applications handbook, 2008). Evaluated flour was obtained by milling of the wheat grain samples on a Bühler mill automat MLU 202. A typical Mixolab curve is separated to the five stages represented by five points (C1 – C5) (Fig. 1).



Figure 1 Standard Mixolab curve

The two first stages correspond to the rheological characteristics of proteins as stability, elasticity and water absorption whereas the others stages relate mainly to starch and amylolytic activity. Evaluated characteristics from measured mixolab curve are: C1 (Nm) marks maximum torque during mixing, used to determine water absorption; C1 (min) time required to achieve the maximum torque; C2 (Nm) measures the weakening of the protein based on the mechanical work and the increasing temperature; C3 (Nm) indicates the rate of starch gelatinization; C4 (Nm) represents the stability of the hot-formed gel; C5 (Nm) expresses starch retrogradation during the cooling period; difference C1C2 represents the protein network strength under the increasing heating; difference C3C4 shows diastatic activity; difference C5C4 correlates with the anti-stalling effects, represents shelf life of end products; DS indicates the stability of the dough before weakening (Mixolab Applications Handbook, 2008).

## 3 Results

Our results (Table 1) show considerable differences in DON content between variants with natural contamination and artificial *Fusarium* spp. inoculation. Some authors mentioned an increase of protein content in grain with higher *Fusarium* spp. contamination (Boyacioglu and

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Hettiarachchy, 1995), others, for example Gärtner et al. (2008) mentioned slight decrease on it. In our case, increase of protein and wet gluten content occurred in artificially inoculated variant. At the same time, general reduction of Zeleny sedimentation and Gluten Index in artificially inoculated variant were observed.

This indicates that *Fusarium* spp. infection may alter protein quality in grain. Similar situation – decrease of falling number value in artificially inoculated variant was observed, too. According to Hareland (2003) fungal infection is expected to increase the degradation of starch due to the activity of enzymes as  $\alpha$  - amylase in kernels, which is measurble by means of falling number.

As was mentioned in previous studies, *Fusarium* spp. infection markedly worsen both protein and starch characteristics (Boyacioglu and Hettiarachchy, 1995). That was confirmed also by resulted Mixolab parameters (Table 2a,b).

| Table 1 | DON content and average technological characteristics of wheat with Fusarium |
|---------|--|
|         | spp. inoculation and natural contamination                                   |

| Treatment              | DON     | CP   | WG   | GI   | ZS   | FN    | VW      | TKW  |
|------------------------|---------|------|------|------|------|-------|---------|------|
|                        | (µg kg) | (%)  | (%)  | (%)  | (ml) | (s)   | (kg hl) | (g)  |
| Artificial inoculation | 7495.2  | 13.7 | 30.0 | 42.0 | 34.0 | 250.5 | 50.4    | 23.9 |
| Natural contamination  | 304.7   | 12.0 | 26.1 | 88.3 | 49.3 | 283.8 | 72.8    | 47.3 |

 Table 2a
 Average Mixolab characteristics of wheat with Fusarium spp. inolucation and natural contamination

| Treatment              | reatment C1 |      | C3   | C4   | C5   |
|------------------------|-------------|------|------|------|------|
|                        | (min)       | (Nm) | (Nm) | (Nm) | (Nm) |
| Artificial inolucation | 2.40        | 0.18 | 2.04 | 1.66 | 2.12 |
| Natural contamination  | 3.21        | 0.44 | 2.66 | 1.96 | 2.50 |

C1 – time required for maximum torque during mixing; C2 – protein weakening; C3 – starch gelatinization; C4 – stability of gel; C5 – starch retrogradation

# Table 2b Average Mixolab characteristics of wheat with *Fusarium* spp. inolucation and natural contamination

| Treatment              | C1C2 | C3C4 | C5C4 | DS    |
|------------------------|------|------|------|-------|
|                        | (Nm) | (Nm) | (Nm) | (min) |
| Artificial inolucation | 0.90 | 0.38 | 0.46 | 6.3   |
| Natural contamination  | 0.69 | 0.66 | 0.54 | 9.9   |

C1C2 – fall of protein strenght; C3C4 – diastatic activity; C5C4 – anti-stalling effect; DS – time of dough stability before weakening

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## 4 Conclusions

Our research confirmed the high sensitivity of Mixolab system for monitoring the changes in rheological characteristics of wheat. Worsened rheological quality and hence took up a negative effect on protein and on the starch were observed in variant with higher *Fusarium* spp. infestation, evoked by artificial inoculation of flowering ears.

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