SHORT COMMUNICATIONS

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THE MYCOTOXIN CONTAMINATION OF TRITICALE CULTIVARS CULTIVATED IN ORGANIC AND CONVENTIONAL SYSTEMS OF PRODUCTION

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Abstract

Content of mycotoxins in grain of triticale cultivars grown in organic and conventional system of production was estimated. From among 13 examined cultivars of organic triticale deoxynivalenol was identified in all samples (up to 0.32 mg/kg) and T-2 toxin was detected in 11 samples (< 75 μg/kg). From among 13 examined cultivars of conventional triticale deoxynivalenol was identified in four samples, but the toxin content in two cultivars was high. T-2 toxin was identified in five samples but the toxin content in two cultivars was high. The aflatoxins and ochratoxin A were not found in triticale grain from any of the production systems.

Key words: triticale cultivars, deoxynivalenol, T-2 toxin, aflatoxins, ochratoxin A, organic, conventional

Introduction

Mycotoxin contamination of grain is a serious problem in conventional and organic cereal production. It results in dry matter, quality and nutritional losses, representing a significant hazard in the food and feed chain. The most important mycotoxin-producing fungi belong to the genera *Aspergillus, Fusarium* and *Penicillium*. Mycotoxins differ considerably in both their chemical structure and in their toxicological effects. Aflatoxins and ochratoxin A are carcinogens, whereas DON, T-2, HT-2 are immunosuppressants (Olsen 2008).

Fusarium head blight (FHB) caused by various *Fusarium* species is an exterminating disease of triticale (× *Triticosecale*) and other cereals. It causes not only yield

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and quality losses but also grain contamination with mycotoxins (Miedaner et al. 2004). Trichothecenes are a large group of toxic secondary metabolites produced by several fungi of the *Fusarium* genus. The trichothecene deoxynivalenol (DON) produced by *F. graminearum* and *F. culmorum* have occurred in toxicologically relevant concentrations in cereal grains worldwide (Miedaner et al. 2001). The trichothecene T-2 toxin and HT-2 toxin produced mainly by *F. poae*, *F. sporotrichioides* and *F. langsethiae* are of particular importance due to their increased occurrence and higher toxicity (Aldred and Magan 2004, Beyer et al. 2009). The above mentioned *Fusarium* mycotoxins are produced in grain during the growth of cereals in the field. Other fungi such as the OTA-producing species *Penicillium verrucosum* and aflatoxins-producing *Aspergillus flavus,* primarily invade the crops and produce toxins during drying and storage (Olsen 2008). Therefore it is very important to reduce mycotoxin contamination level already in the field by applying appropriate agronomical measures and growing more resistant cultivars (Aldred and Magan 2004).

The aim of this study was to determine mycotoxins level in kernels of different triticale genotypes cultivated in organic and conventional systems of production.

Materials and methods

Grain of 13 *Triticale* cultivars from the Experimental Organic Farm in Chwałowice and 13 conventionally grown *Triticale* cultivars from the Experimental Farm of Cultivars Estimation in Cicibór in 2008 was examined for aflatoxins, ochratoxin A, deoxynivalenol, and T-2 toxin content by enzyme-linked immunosorbent assay. Commercial ELISA kits: AgraQuant Total Aflatoxin Assay, AgraQuant T-2 Toxin Assay, AgraQuant Ochratoxin Assay, AgraQuant DON Assay were used in the study. The kits are direct competitive immunoassays with horseradish peroxidase conjugate. ELISA test was performed according to the procedure described in the AgraQuant Assay kit manual.

Ground samples (20 g) were extracted with 100 ml of 70% methanol in a ratio of 1:5 (w:v) for T-2 toxin, ochratoxin A, aflatoxins and with 100 ml of distilled water for deoxynivalenol by shaking for 3 min and filtering through Whatman No. 1 paper. Samples were diluted with distilled water in a ratio of 1:10 for T-2 toxin and with 1:5 ratio for deoxynivalenol.

Aliquots of 100 μl of all extracts were used further in the procedure.

Absorption in microwells was measured with a Tecan Sunrise microwell reader using a 450 nm absorbance filter.

Statistical analysis was performed with Statgraphics Centurion XV software (StatPoint, Inc., Herndon, VA, USA). Multifactor variance analysis (ANOVA) was used to compare concentrations of deoxynivalenol and T-2 toxin in cultivars from organic and conventional farming at $p < 0.05$.

Results

Aflatoxins and ochratoxin A were not found in any of the examined samples of winter *Triticale* (Tables 1, 2). Cultivars: 'Gniewko', 'Grenado', 'Moderato', 'Pawo', 'Trismart', 'Witon' and 'Woltario' were represented in both organic and conventional farming systems. The presence of deoxynivalenol and T-2 toxin in these cultivars is shown in Table 3.

In all the examined cultivars of *Triticale* from organic farming deoxynivalenol was identified in quantities up to 0.32 mg/kg, T-2 toxin was identified in 11 samples (all less than 75 μg/kg), while aflatoxins and ochratoxin A were not found. In flour made of grain of *Triticale* from conventional farming deoxynivalenol was identified in four samples (up to 1.29 mg/kg), T-2 toxin was found also in four samples (up to 121.51 μg/kg), while aflatoxins and ochratoxin A were not present.

Among seven cultivars represented in both farming systems, deoxynivalenol was identified only in samples from organic farming, whereas T-2 toxin was identified in five samples from organic farming (all below 75 μg/kg) and two samples from conventional farming (up to 121.51 μg/kg).

The differences in deoxynivalenol and T-2 toxin concentrations between both cropping systems were statistically insignificant and p-value amounted for DON 0.4061 and for T-2 toxin 0.0877.

Table 1

The occurrence of mycotoxins in cultivars of triticale in organic system of production

Cultivar	DON (mg/kg)	T-2 (μg/kg)	Aflatoxins (μg/kg)	Ochratoxin A (μg/kg)
'Trismart'	0.3	< 75	0	0
'Moderato'	0.3	< 75	0	0
'Witon'	0.29	< 75	0	0
'Gniewko'	0.31	< 75	0	0
'Woltario'	0.31	0	0	0
'Grenado'	0.29	0	0	0
'Magnat'	0.3	< 75	0	0
'Hortenso'	0.3	< 75	0	0
'Aliko'	0.31	< 75	0	0
'Legalo'	0.31	< 75	0	0
'Modus'	0.32	< 75	0	0
'Benetto'	0.31	< 75	0	0
'Pawo'	0.3	< 75	0	0

Table 2

The occurrence of mycotoxins in cultivars of triticale in conventional system of production

Cultivar	DON (mg/kg)	T-2 (μg/kg)	Aflatoxins (μg/kg)	Ochratoxin A (μg/kg)
'Baltico'	0	0	0	0
'Hewo'	1.29	0	0	0
'Gniewko'	0	0	0	0
'Todan'	< 0.25	0	0	0
'Kazo'	0.89	< 75	0	0
'Woltario'	0	< 75	0	0
'Trismart'	0	0	0	0
'Witon'	0	0	0	0
'Moderato'	0	121.51	0	0
'Pawo'	0	0	0	0
'Algoso'	0	80.77	0	0
'Sorento'	0.29	0	0	0
'Grenado'	0	0	0	0

Table 3

Mycotoxins presence in *Triticale* depending on the farming system

Mycotoxin	Mean (μg/kg)		Range (μg/kg)		No. of (+)/total samples	
	organic	conv.	organic	conv.	organic	conv.
Afla (total)	0	0	0	0	0/13	0/13
OTA	0	0	0	0	0/13	0/13
DON	304	209	290–320	0–1290	13/13	4/13
T-2 toxin	63.461	27.098	0–< 75	0–121.51	11/13	4/13

Discussion

Among *Fusarium* mycotoxins, trichothecenes are frequently encountered in cereals crops (Bountigny 2008). In our study trichothecene DON from the type B was predominant in examined triticale cultivars cultivated in both organic and conventional production systems. Deoxynivalenol was detected in all triticale cultivars in organic production system but the toxin content in grain was low (max. 0.32 mg/kg). Although the mycotoxin occurred only in four cultivars in the conventional system, in two of them its content was high and the limit for cereal grain was exceeded in one case (cv. 'Hewo'). T-2 and HT-2 toxins are frequently found together in various cereal crops. Based on their relevance in food samples, it is intended to implement a combined maximum level for the mycotoxins in the

near future (Beyer et al. 2009). T-2 toxin like DON was found in the majority tested cultivars growing in organic farming but the content of the toxin was very low. Only four cultivars grown in conventional system contained T-2 toxins, including two with very high content. Our study showed that the risk of T-2 toxin occurrence increased in conventional systems in the case of high yielding cultivars such as 'Moderato' and 'Algoso' (Cyfert 2007), while the same cultivars cultivated in organic system contained low level of the toxin. The comparison of DON content in grain of nine winter wheat cultivars under organic and conventional cropping systems in three-year experiments in the Czech Republic also showed lower values for this toxin in grain from organic system production (Váňová et al. 2008). Due to the fact that conventional compared to organic farming in general shows narrower crop rotations with a higher number of risky forecrops, as well as a higher nitrogen fertilization in combination with the use of growth regulators and a less intensive soil tillage, Schollenberger et al. (2002) judge the risk of potential contamination of cereals with mycotoxins in Germany to be lower in organic than in conventional farming. These results confirm great importance of production systems and cultivars in the aspect of mycotoxin content reduction in cereal grain.

The determined levels of DON and T-2 toxin were very low in cultivars from the organic cropping system under study, whereas the majority of cultivars from conventional cropping system was not contaminated. Yet, the cultivars which were contaminated, were so heavily contaminated, that there was no significant differences in the DON and T-2 toxin contents between triticale grain from organic and conventional systems of production. Edwards (2009) also claimed that no significant difference was found in DON concentration between organic and conventional wheat samples analyzed in the UK.

Absence of aflatoxins and ochratoxin A in the tested material could be an evidence of good post-harvest management of stored triticale in both farms. Targeted research has made it clear that there was presently no increased occurrence of fungal toxins in organic cereals, when standard good practices for harvest and storage of dried grain are followed.

Over the last years, antibody-based immunoanalytical methods such as ELISA have become very popular screening tools for mycotoxin contamination. They are rapid, not as expensive as LC or GC chromatography and the comparison of them to LC or GC methods shows high correlation (Krska 2007).

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