SHORT COMMUNICATION

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COMPARISON OF MYCOTOXIN CONTAMINATION OF WINTER RYE AND TRITICALE CULTIVARS

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Abstract

The content of mycotoxins in grain of winter rye and triticale cultivars grown in conventional system of production was estimated. From among 13 examined triticale cultivars deoxynivalenol (DON) was identified in four samples, but the toxin content in two cultivars was high. From among 23 examined rye cultivars DON was identified in eight samples, but the toxin content in three cultivars was very high. T-2 toxin was identified in five samples of rye and four samples of triticale but the toxin content in two triticale cultivars was very high. Due to high content of tested mycotoxins in some cultivars, average content of DON was higher in rye cultivars and average content of T-2 was higher in triticale cultivars, however the differences were not statistically significant. The aflatoxins and ochratoxin A were not found in winter rye and triticale grain. A large number of the cultivars of two tested cereal species was free from any of the mycotoxin tested.

Key words: winter rye, winter triticale, cultivars, deoxynivalenol, T-2 toxin, aflatoxins, ochratoxin A

Introduction

The occurrence of mycotoxins in various crops is a food safety issue of great concern worldwide. Trichothecenes (frequently found in cereals) are secondary metabolites produced mainly by Fusarium ear blight pathogens (Lattanzio et al. 2008, Beyer et al. 2009). Also fungi from genera *Aspergillus* and *Penicillium* are considered the most significant in grains and foods, because of their ability to produce dangerous mycotoxins, such as aflatoxins and ochratoxin A (Hussein and Brasel

Phytopathologia 63: 51–56

ISSN 2081-1756

2001, Binder et al. 2007). Mycotoxins are formed during cereal growth or in post-harvest storage. It has been estimated that ca 25% of cereals can be contaminated by mycotoxins. They are not completely removed by cleaning and can be carried through into processed foods. Human and animal health risks depend on the mycotoxin toxicity, contamination level and quantity of the contaminated food consumed. It is recommended that risk reduction measures are best employed at the farming stage by selecting appropriate cultivars, agronomic practices and using effective storage practices (Binder et al. 2007).

Rye and triticale are economically important crops in Europe. Most of mycotoxins contamination studies were performed in winter wheat, while little is known about the mycotoxins accumulation in rye and triticale grain. The aim of this study was to estimate mycotoxins contamination of winter triticale and rye cultivars harvested grain.

Materials and methods

Grain of 13 winter triticale cultivars and 23 winter rye cultivars harvested in 2009 at the Experimental Farm of Cultivars Estimation in Cicibór was examined for deoxynivalenol, T-2 toxin, aflatoxins and ochratoxin A 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 l 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 rye and triticale cultivars at $p < 0.05$.

Results

From among 23 examined cultivars of rye DON was identified in eight samples, but the toxin content in three cultivars was very high and amounted 2.42, 3.79 and 6.23 mg/kg (Table 1). From among 13 examined cultivars of triticale deoxynivalenol (DON) was identified in four samples, but the toxin content in two

Table 1

Content of mycotoxins in cultivars of winter rye grain

Cultivar	DON (mg/kg)	T-2 (μg/kg)	Aflatoxins (μg/kg)	Ochratoxin A (μg/kg)
'Picasso'	0	0	0	0
'Herkules'	0	0	0	0
'Bosmo'	6.23	0	0	0
'Placido'	0	0	0	0
'Słowiańskie'	< 0.25	< 75	0	0
'Skat'	0	0	0	0
'Dańkowskie Złote'	0.27	0	0	0
'Matador'	0	< 75	0	0
'Balastic'	0	0	0	0
'Daran'	0	0	0	0
'Walet'	0	0	0	0
'Warko'	0	0	0	0
'Kier'	0	< 75	0	0
'Stanko'	2.42	0	0	0
'Roztockie'	0	0	0	0
'Konto'	0	< 75	0	0
'Stach'	0	0	0	0
'Fernando'	< 0.25	0	0	0
'Caroass'	0.33	< 75	0	0
'Agrokolo'	3.79	0	0	0
'Amilo'	< 0.25	0	0	0
'Visello'	0	0	0	0
'Dańkowskie Diament'	0	0	0	0

cultivars was high and amounted 0.89 and 1.29 mg/kg (Table 2). T-2 toxin was identified in five samples of rye and four samples of triticale but the toxin content in two triticale cultivars was very high and amounted 80.77 and 121.51 μg/kg (Tables 1 and 2). Due to high content of the tested mycotoxins in some cultivars, average content of DON was higher in rye cultivars and average content of T-2 was higher in triticale cultivars (Fig. 1). The differences in DON and T-2 toxin concentrations between cultivars of two cereal species were statistically insignificant and p-value amounted for DON 0.37 and for T-2 toxin 0.04 (Table 3).

The aflatoxins and ochratoxin A were not found in winter rye or triticale grain (Tables 1 and 2). Almost a half of tested triticale cultivars and above a half of rye cultivars were free from all tested mycotoxins (Tables 1 and 2).

Table 2

Content of mycotoxins in cultivars of triticale grain

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

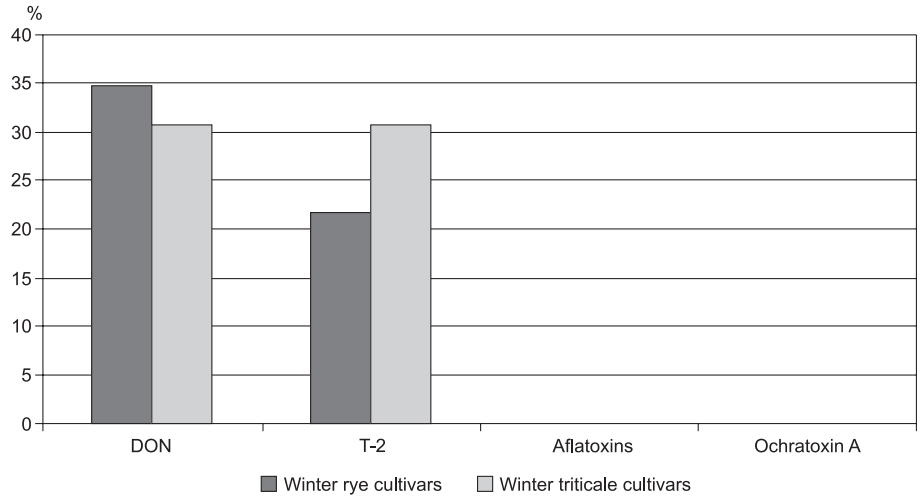

Fig. 1. Share of winter rye and triticale cultivars contaminated by mycotoxins

Discussion

Trichothecenes as common contaminants occurring in cereals are especially well-known inhibitors of protein synthesis, including DNA, RNA synthesis, inhibitors of mitochondrial function, effect cell division and membrane effects (Yazar and Omurtag 2008). Deoxynivalenol (DON) representing trichothecene B group

Table 3

Comparison of DON and T-2 content in kernels of winter rye and triticale cultivars

Mycotoxin	$\bar{x}$ ±SD		p-Value (ANOVA)
	winter rye	winter triticale	
DON (mg/kg)	0.6 a ±1.52	0.21 a ±0.41	0.37
T-2 (μg/kg)	16.3 a ±31.63	27.1 a ±43.77	0.4

Results marked with the same letter do not differ statistically significantly ($p > 0.05$).

occurred in some cultivars of both tested cereals, but in a few cultivars the maximum level of the mycotoxin was exceeded in cereal products established by the EU Commission Regulation (1.25 mg/kg), especially in rye. T-2 toxin is one of the most toxic mycotoxins belonging to trichothecenes group A. *Fusarium sporotrichioides* and *F. poae* are main producers of it (Beyer et al. 2009). In the study, T-2 toxin was found in cultivars of both cereals but in very high amounts in some triticale cultivars. The toxin in such amounts in grain is very dangerous for man, because consumption of even small quantities of products from the grain exceed tolerated daily intake (TDI) for mixture of T-2 and HT-2 toxins amounting 0.06 μg per 1 kg of body weight per day (Lattanzio et al. 2008, Beyer et al. 2009). The results of the study indicated that the contamination of triticale by DON was lower than rye and are in accordance with results obtained by Miedaner et al. (2001).

The grain of rye and triticale cultivars differed in their susceptibility for DON and T-2 contamination. Similar results were obtained by other authors on different cereal cultivars (Miedaner et al. 2001, Pettersson et al. 2008, Edwards et al. 2009). The large genotypic variation in triticale and rye offers good possibilities for reducing DON and T-2 toxin content in the grain by choice of cultivars with low susceptibility for mycotoxin contamination.

Streszczenie

PORÓWNANIE ZANIECZYSZCZENIA ODMIAN PSZENŻYTA I ŻYTA PRZEZ MIKOTOKSYNY

Określono zawartość mikotoksyn w ziarnie wybranych odmian ozimego żyta i pszenżyta uprawianych w konwencjonalnym systemie produkcji. Spośród 13 badanych odmian pszenżyta deoksyniwalenol (DON) zidentyfikowano w czterech próbkach, przy czym zawartość tej toksyny w dwóch odmianach była duża. Spośród 23 badanych odmian żyta DON wykryto w ośmiu próbkach, przy czym zawartość tej toksyny w trzech odmianach była bardzo duża. Toksynę T-2 wykryto w pięciu odmianach żyta i czterech pszenżyta, ale zawartość tej toksyny w dwóch odmianach pszenżyta była bardzo duża. Z powodu dużej zawartości mikotoksyn

w kilku odmianach średnia zawartość DON była większa w odmianach żyta, a średnia zawartość toksyny T-2 w odmianach pszenżyta, jakkolwiek różnice te nie były istotne statystycznie. Aflatoksyn ani ochratoksyny A nie stwierdzano w badanych zbożach. Duży udział odmian obu gatunków zbóż stanowiły odmiany wolne od badanych mikotoksyn.

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Accepted for publication: 3.06.2012