THE OCCURRENCE OF MYCOTOXINS IN CEREAL GRAINS IN 2019

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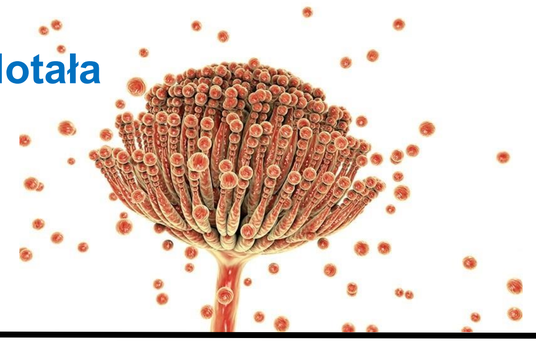


INTRODUCTION

Mycotoxins are secondary metabolites of micro-fungi and occur in all farming systems. Mycotoxin contamination of cereal grains is a serious problem in agricultural production worldwide. There is a large variation in the year-to-year results regarding the detected mycotoxin levels, due to the impact of applied agrotechnic and geo-climatic conditions.

The aim of the study was to evaluate the content of mycotoxins in Polish cereals harvested in 2019. The research was carried out by Department of Pesticide Residues Research of Institute of Plant Protection – National Research Institute within the framework of the multi-annual program “Protection of cultivated plants with the consideration of food safety, reduction of yield losses and threat to humans, livestock and the environment” financed by Minister of Agriculture and Rural Development.

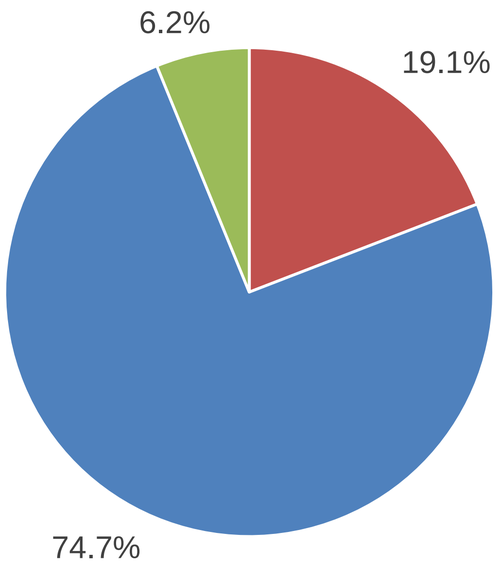
MATERIALS AND METHODS

The research program included 7 species of cereals: barley, maize, cereal mix, oat, wheat, triticale and rye. Samples of cereal grains were collected from production sites by inspectors of Plant Health and Seed Inspection. In total, 162 samples of cereal grains were analysed for 14 mycotoxins: aflatoxin B1 and B2 (afla B1 and B2), aflatoxin G1 and G2 (afla G1 and G2), ochratoxin A (OTA), fumonisin B1 and B2 (FUM B1 and B2), deoxynivalenol (DON), 3-acetyl-deoxynivalenol (3-AcDON), 15-acetyl-deoxynivalenol (15-AcDON), nivalenol (NIV), HT-2 toxin, T-2 toxin and zearalenone (ZEA).

A multi-method [1] based on the method developed by the National Reference Laboratory for Food and Feed Pesticide Residues in Wageningen, the Netherlands, was applied to the determination of mycotoxins. Acetonitrile/water extraction for isolation of mycotoxins and a twenty-times dilution of the extract to minimize matrix effects was used.

The chromatographic determination of mycotoxins was performed using an Eksigent ekspert ultraLC 100-XL system interfaced with a mass spectrometer equipped with an electrospray-ionization source operated in the positive and negative mode (AB Sciex, Qtrap 6500). Chromatographic separation was achieved using a Kinetex C18 (100 x 2.1mm x 1.7µm) column and water/methanol gradient. Multiple reaction monitoring (MRM) mode was used for detection and quantification of analytes.

THE OCCURRENCE OF MYCOTOXINS IN CEREALS



MYCOTOXINS CONTENT IN THE TESTED CEREAL GRAIN SAMPLES

Cereal grains	Mycotoxins content in µg/kg							
	OTA	FUM B1+B2	T-2 + HT-2	ZEA	DON	3-ACDON	15-AC DON	NIV
Barley	1.5−7.8	11.0−37.9	1.2−112.9	5.7	71.9−206.0	28.2	9.9	368.8−417.1
Maize	0.9−2.0	18.4−1589.0	1.0−43.5	8.6−136.1	138.9−1999.0	36.2−58.3	10.2−110.9	-
Cereal mix	2.1−5.1	11.5−24.2	2.0−52.5	5.5	-	-	-	-
Oat	0.8−3.1	-	1.2−64.8	-	-	-	-	-
Wheat	0.8−2.2	-	1.1−21.7	7.1−7.2	41.9−697.5	-	4.2−9.9	-
Triticale	0.9−1.9	-	2.1−8.4	7.4	74.8−891.5	-	4.7−21.6	-
Rye	0.6−3.1	-	1.0−5.7	-	181.6−1265.6	-	27.5	-

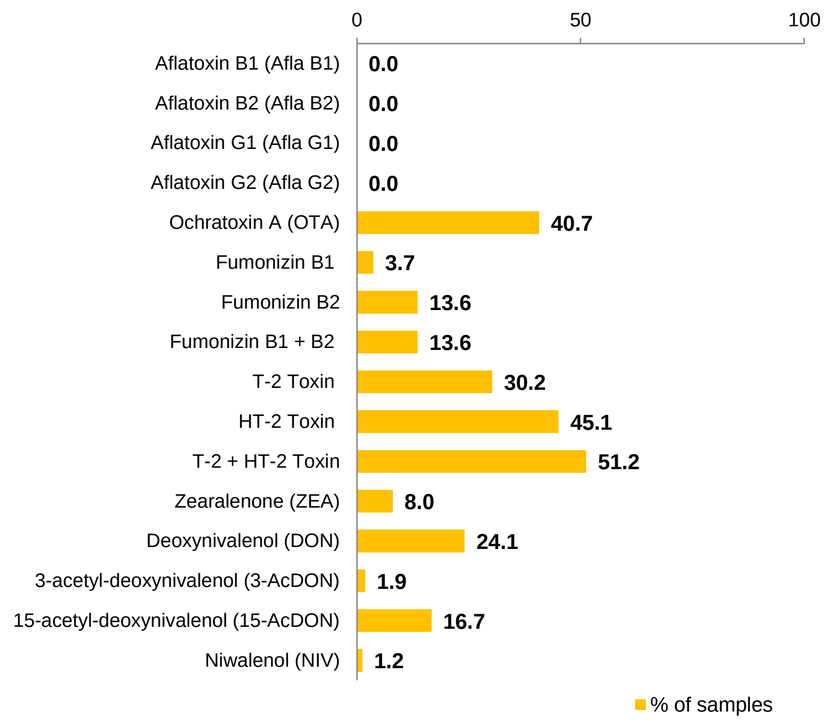
„–” below the limit of quantification (LOQ)

RESULTS

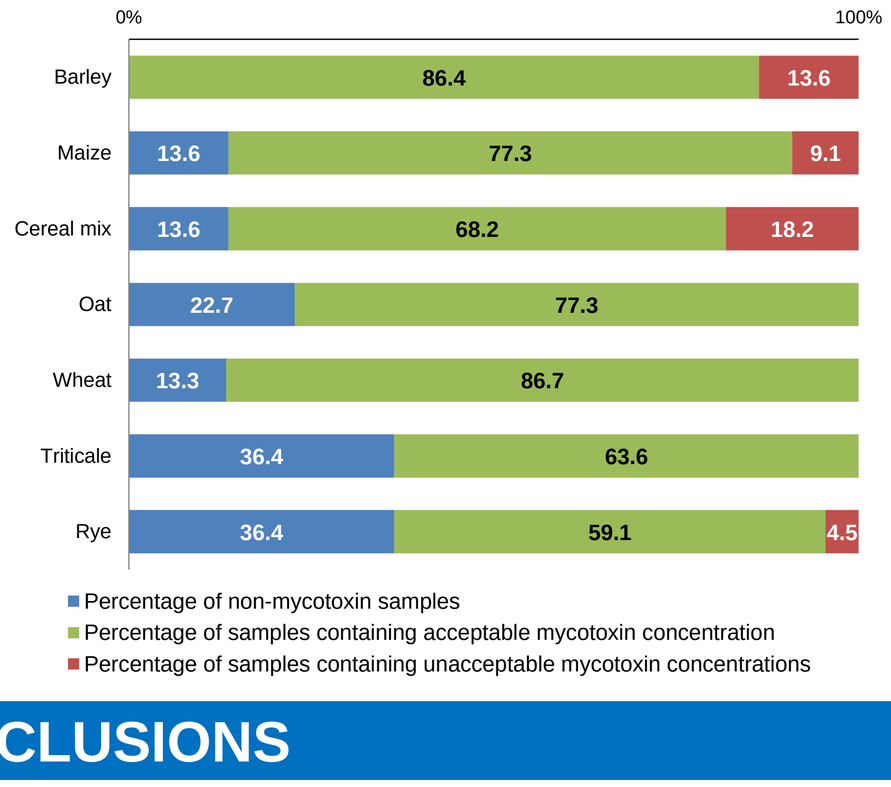
The samples of cereal grains were contaminated with 10 mycotoxins produced by *Fusarium* and *Penicillium* species. Overall, 80.9% of the samples contained mycotoxins, including OTA (40.7%), HT-2 (45.1%) and T-2 (30.2%), DON (24.1%) and it’s two derivatives – 15-AcDON (16.7%) and 3-AcDON (1.9%), also ZEA (8.0%), FUM B1 (3.7%), FUM B2 (13.6%) and NIV (1.2%). In 49.4% of the samples tested multiple mycotoxins were found, maximum 7.

Mycotoxins were found in barley (100.0%), wheat (86.7%), maize and cereal mix (86.4%), oat (77.3%), triticale and rye (63.6%). The percentage of tested samples of 4 cereal species with concentrations of mycotoxins exceeding maximum levels [2,3] was the highest in cereal mix (18.2%) and barley (13.6%), lower in maize (9.1%) and rye (4.5%). Overall, violations of maximum levels of mycotoxins were found in 6.2% of the samples.

FREQUENCY OF INDIVIDUAL MYCOTOXINS



THE OCCURRENCE OF MYCOTOXINS IN INDIVIDUAL CEREALS



CONCLUSIONS

- In 80.9% of tested samples mycotoxins were detected. The percentage of samples with multiple mycotoxins was 49,4%.
- Two mycotoxins (OTA, DON) were found at the concentration higher than the regulatory limits.
- Mycotoxin contents above the maximum levels, that could posing a potential risk to human and animal health, were found in 6.2% of the samples.

REFERENCES

[1] Kazimierczak R., Średnicka-Tober D., Leszczyńska D., Nowacka A., Hallmann E., Barański M., Kopczyńska K., Gnusowski B. 2020. Evaluation of Phenolic Compounds and Carotenoids Content and Mycotoxins Occurrence in Grains of Seventeen Barley and Eight Oat Cultivars Grown under Organic Management. Appl. Sci. 2020, 10(18), 6369; https://doi.org/10.3390/app10186369

[2] Commission Regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs.

[3] Commission Recommendation of 27 March 2013 on the presence of T-2 and HT-2 toxin in cereals and cereal products.