Bulgarian Journal of Agricultural Science, 13 (2007), 99-104
National Centre for Agrarian Sciences

The Fusariotoxins Zearalenon and Deoxinivalenol as Natural Contaminators of Some Basic Cereal Components in the Production of Combined Feed

A. VALCHEVA and G. VALCHEV
Institute of Animal Science, BG – 2230 Kostinbrod, Bulgaria

Abstract

VALCHEVA, A. and G. VALCHEV, 2007. The distribution of moulds of genus *Fusarium* in basic cereals used in production of combined feed. *Bulg. J. Agric. Sci.,* 13: 99-104

The aim of the present investigation is to evaluate the presence of mycotoxins Zearalenon and Deoxinivalenol as natural contaminators of the basic cereal components of combined feed in this country – maize, wheat, barley and oats.

A total of 281 samples, including maize 104, wheat 103, barley 39 and oats 35, stock cereals from 2003 – 2005 crops had been evaluated.

More favorable substrates for their accumulation had been maize, wheat and barley, while for oats the presence was established only in some of investigated years.

The average concentrations of Zearalenon for maize vary between 398 and 838 μg/kg, for wheat between 450 and 884 μg/kg, for barley between 320 and 378 μg/kg, for oats between 250 and 350 μg/kg.

The average concentrations of Deoxinivalenol for maize vary between 237 and 372 μg/kg, for wheat between 336 and 678 μg/kg, for barley between 250 and 333 μg/kg, and for oats 250 μg/kg.

Key words: maize, wheat, barley, oats, mycotoxins, Zearalenon, Deoxinivalenol

Introduction

The contamination of feeds and foods by moulds and mycotoxins is considered as one of the major factors related to safety for consumers (Gremmels, 2005; Scadamore, 2005). Their effect upon organisms is linked to the health status and productivity of animals and birds.

The mycotoxins can cause acute intoxications under high contamination of feeds, but more important is two facts that they are highly dangerous even in rather low quantities, because of their cumulative, immunosuppressive and immunotoxic action. All these can seriously worsen the health; deteriorate the appetite and feed

conversion as well as animal productivity (Gremmels, 2005).

The fusariotoxins Zearalenon and trihotecene mycotoxins including Deoxinivalenol produced by some species of genus Fusarium lead to a number of diseases in animals and bird having as a consequence a considerable loss of production and a high rate of mortality.

The Zearalenon has a pronounced estrogenic action and the response of a number of animals thereof (Pathre et al., 1980) but particularly sensitive in this respect are swine (Mirocha, 1977; Van Gulick, 1993; Dacasto et al., 1995).

The Deoxinivalenol inhibits the DNA and RNA synthesis, has a hemolytic effect (hemolisis of erythrocytes), leads to a poor feed conversion and hence to a reduction of live weight. It also has an immunosuppressive action (Rotter et al., 1996; Erikson and Alexander, 1998; Baars et al., 1999).

The aim of the present investigation is to evaluate the presence of mycotoxins Zearalenon and Deoxinivalenol as natural contaminators of the basic cereal components of combined feed in this country – maize, wheat, barley and oats.

Materials and Methods

A total of 281 samples, including maize 104, wheat 103, barley 39 and oats 35, stock cereals from 2003 – 2005 crops had been evaluated. All samples were supplied by different productive regions countrywide.

The samples are representative and had been taken according Bulgarian Standard 11374/86. the prove and quantitative determination of the Zearalenon mycotoxin had been done by the method of the thinlager chromatography (Bulgarian Standard 11374/86) and of the Deoxinivalenol by the method of Sobolev (1985).

Results and Discussion

The research carried out for the period under study had given us the possibility to reveal the mycotoxicologic status of evaluated cultures with respect to two mycotoxins – Zearalenon and Deoxinivalenol.

It is evident from data in Table 1 that the mycotoxin Zearalenon is available in all studied cultures, its quantity varying widely.

Similar percent values for positive samples show maize 43.2% and wheat 42.7%. Lower percent positive samples are indicated for barley 35.8% and even lower for oats 8.5%.

Higher concentrations of Zearalenon in maize had been proved from 100 to 3500 μg/kg for the 2003 crop and 100 to 4500 μg/kg for the 2004 crop. This is the highest quantity value of this mycotoxin for the four cultures and the period of investigation.

Higher concentrations had been found for barley in the same annual crop 200 to 1000 μg/kg for 2003 and 200 to 900 μg/kg for 2004.

The lowest proven quantities of Zearalenon had been found in oats. For 2003 crop the values from two samples were in the range 200 to 500 μg/kg, and for 2004 crop a quantity of 250 μg/kg was found from one sample.

Table1
Contents of Zearalenon

Crops	Number of samples	Number of positive samples	Persent of total nimber	Content of micotoxin, μ g/kg
Maize				
2003	34	16	47	100 – 3500
2004	40	22	55	100 – 4500
2005	30	7	23.3	100 – 800
Wheat				
2003	34	14	41.1	300 – 4500
2004	38	24	63.15	90 – 6000
2005	31	6	19.3	100 – 1500
Barley				
2003	15	7	46.6	200 – 1000
2004	12	4	33.3	200 – 900
2005	12	3	25	100 – 600
Oats				
2003	10	2	20	200 – 500
2004	13	1	7.6	250
2005	12	-	-	-

It can be noted that for all four cereals the contents of Zearalenon is much lower for the 2005 crop – 100 to 800 μg/kg for maize, 100 to 1500 μg/kg for wheat, 100 to 600 μg/kg for barley, and absence for oats.

The average concentrations of Zearalenon by years and by cultures are depicted in Figure 1.

It is very rear to find a single mycotoxin in cereals.

They usually are found as combinations of various mould metabolites. The Zearalenon is frequently found as a natural contaminator of cereals together with Deoxinivalenol (Valcheva, 2000; Tankov, 2000). This is due to the fact that the main producer of both mycotoxins is *F.graminearum* (Muller et al., 1997; Molto et al., 1997).

This was the reason why samples analyzed for Zearalenon were examined for the presence of Deoxinivalenol as well.

Table 2 shows the results of determination of Deoxinivalenol contents.

Highest percent positive samples for the investigation period with respect to Deoxinivalenol contamination were found for wheat 43.6%, barley 20.5%, maize 18.2% and oats 5.7%.

The high percent positive samples for wheat correlate with proven higher concentrations of Deoxinivalenol. The highest concentration had been proven for

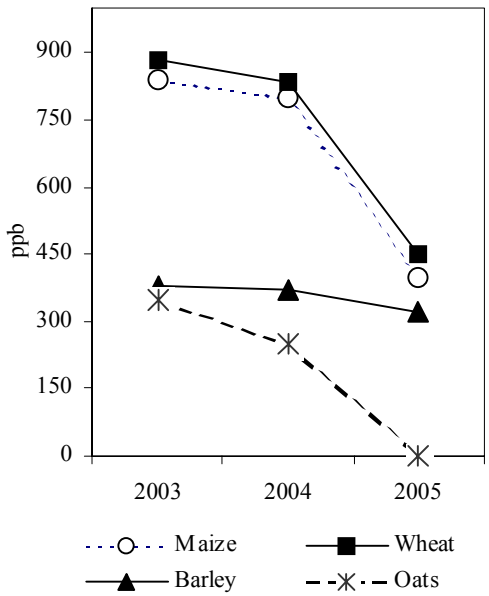

Fig. 1. Average concentrations of Zearalenon by years and by cultures

2004 crop from 200 to 2500 µg/kg, and the lowest for 2005 crop from 200 to 1000 µg/kg.

For maize the highest concentration of mycotoxins was proven also in 2004 crop from 200 to 500µìg/kg, and the lowest in the 2005 crop 250 µg/kg evidenced in only one sample.

Figure 2 shows proven average concentrations of Deoxinivalenol by years and by cultures.

It could be noted that the proven average concentrations of Zearalenon and Deoxinivalenol for the last year under study, 2005 are considerably lower than previous years, which is not in correlation with the established high percent of damage by moulds of genus Fusarium registered in other our investigations.

Table 2
Contents of Deoxinivalenol

Crops	Number of samples	Number of positive samples	Persent of total nimber	Content of micotoxin, g/kg
Maize				
2003	34	16	17.6	200 – 450
2004	40	9	22.5	200 – 500
2005	30	4	13.3	200 – 300
Wheat				
2003	34	17	50	200 – 2000
2004	38	21	55.2	200 – 2500
2005	31	7	22.5	200 – 1000
Barley				
2003	15	4	26.6	200 – 350
2004	12	3	25	200 – 500
2005	12	1	8.3	250
Oats				
2003	10	2	20	200 – 300
2004	13	-	-	-
2005	12	-	-	-

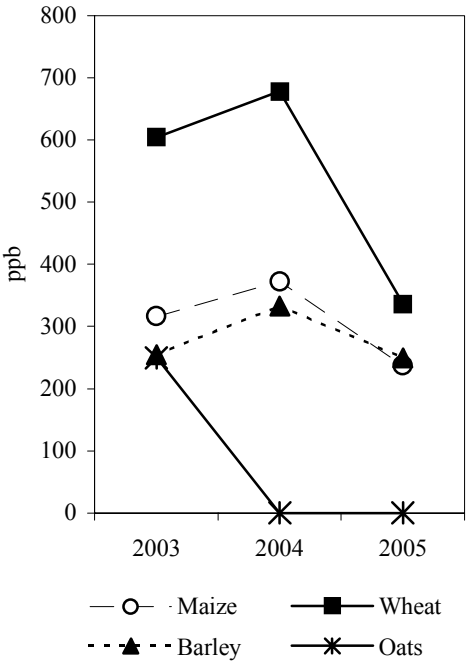

Fig. 2. Average concentrations of Deoxinivalenol by years and by cultures

It is known that toxin formation depends on a complex of factors, e.g. soil and climatic conditions, substrate specificity and last but not least the oxygenic potential of producers. It should not be omitted either that the moulds of genus Fusarium are capable of producing a large number of toxic metabolites apart from Zearalenon and Deoxinivalenol, which is not the task of the present research.

According to Directive 98/53 of EU, the maximum permitted quantities for these two mycotoxins in cereals are 300 ppb for Zearalenon and 100 ppb for Deoxinivalenol.

Our results show that the Zearalenon found the four cereals exceeds these rates, except for 2004 and 2005 oats crops in which it was not found.

The same applies to the proven concentrations of Deoxinivalenol i.e. exceeding these rates for all cultures except 2004 - 2005 oats crop.

According to Regulation 31 dated 29/07/2004 of Ministry of Health concerning maximum allowable quantities of concentration in foods, the rates for mycotoxins in cereals are 200 ppb for Zearalenon and 1000 ppb for Deoxinivalenol. The Zearalenon concentrations proven by us exceed these rates except 2005 oats crop, and Deoxinivalenol are lower than these rates.

Conclusions

The fusariotoxins Zearalenon and Deoxinivalenol had been found as natural contaminators on basic cereal components of combined feed for the period 2003 – 2005.

More favorable substrates for their accumulation had been maize, wheat and barley, while for oats the presence was established only in some of investigated years.

The average concentrations of Zearalenon for maize vary between 398 μg/kg and 838 μg/kg, for wheat between 450 and 884 μg/kg, for barley between 320 and 378 μg/kg , for oats between 250 and 350 μg/kg.

The average concentrations of Deoxinivalenol for maize vary between 237 μg/kg and 372 μg/kg, for wheat between 336 and 678 μg/kg, for barley between 250 and 333 μg/kg, and for oats 250 μg/kg.

References

Baars, A.J., M.Van Apeldoorn, M.Wouters, 1999. Deoxinivalenol. Derivation of concentration limits in wheat and wheat containing products. In: Pieters, M.N. et al. (Editors), Appendin 1 Toxicology, RIVM report 388802008, Rijks Instiut voor Volksgezondheid en Milieu, Bilthoven, The Netherlands.

Bulgarian State Standard – 11374, 1986 (Bg).

Dacasto, M., P. Rolando, C. Nachtmann, L. Ceppa and C. Nebbia, 1995. Zearalenone mycotoxicosis in piglets suckling sows fed contaminated grain. *Vet. Human Toxicol*., **37:** 359 – 361.

Eriksen, G. S. and J. Alexander, 1998. Fusarium toxins in cereals – a risk assessment. Nordic Council of Ministers; Tema Nord 1998; 502, pp. 7-27 and 45-58, Copenhagen.

Grememels, F. J., 2005. Mycotoxicoses in Animal Health. In: S.Denev (Editor), Evaluating the impact of micotoxins in Europe. (Alltech, Proceeding of the European Mycotoxin Seminar, 22nd February 2005, Sofia, Bulgaria), pp. 25-47.

Mirocha, C. J., S. V. Pathre and C. M. Christensen, 1977. Zearalenon. In: J.V.Rodricks et al.(Editors), Mycotoxins in Human and Animal Health. Pathopox Publ.Inc., Park Forest South, pp. 345 – 364.

Molto, G. A., H. H. Gonzalez, S. L. Resnik and A. Pereyra-Gonzalez, 1997. Production of trichotecenes and zearalenon by isolates of Fusarium spp.from Argentinian maize. *Food Addit.Contam.*, **14**: 263 – 268.

Müller, H. M., J. Reimann, U. Schumacher and K. Schwadorf, 1997. Occurrence of Fusarium toxins in barley harvested during five years in area of South – West Germany. *Mycopathologia*, **137**: 185–192.

Pathre, S. V. and C. J. Mirocha, 1980. Micotoxins as estrogens. In: J.A. McLachlan (Editor), *Estrogens in the Enviroment*, *Elsevier*, Amsterdam, pp.265 – 278.

Rotter, B. A. and D. B. Prelusky, 1996. Toxicology of deoxinivalenol (Vomitoxin). *J.Toxicol. Environ Health*, **48**: 1-34.

Scudamore, K. A., 2005. Management of micotoxins in nutritive chain. In: S.Denev (Editor), *Evaluating the impact of micotoxins in Europe* (Alltech, Proceeding of the European Mycotoxin Seminar, 22nd February 2005, Sofia, Bulgaria), pp. 118-138.

Sobolev, V. S., 1985. Chemical methods of analysis of trichotecene micotoxins. In: V.A.Tutelyan (Editor), *Evaluation of the food pollution with micotoxins*. Vol.III. *Control of food pollution with micotoxins*, *International Project Cente-GKNT*, Moskva, pp. 216 – 238 (Ru).

Tankov, D., 2000. Study on the mycoflora and distribution of Zearalenon and Deoxinivalenol on the wheat and maize for feed productions, *Dissertation, Institute of Grain and Feed Industry,* Kostinbrod, 123 pp. (Bg).

Valcheva, A., 2000. Mycological and Mycotoxicological status of wheat. Proof of Deoxinivalenol (DON) from the group of trihotecene micotoxins. *Animal Science*, **5/6**: 93 – 96 (Bg).

Valcheva, A., 2003. Distribution of Zearalenon and Deoxinivalenol and their producers from genus Fusarium as natural contaminators of wheat and maize. *Animal Science*, **3/4**: 163 – 166 (Bg).

Valcheva, A., 2005. Investigations of mycological and mycotoxiclogical status of maize and wheat by feeding of poultry and swine. Dissertation, Institute of Animal Science, Kostinbrod, 120 pp.(Bg).

Van Gulick, P. J. M. M., 1993. Could mycotoxins in Dutch pig farming indicate certain management problems. *Tijdschr. Diergeneeskd*, **118**: 46-51.

Received September, 12, 2006; accepted November, 16, 2006.