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Zearalenone Contamination in Corn

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Abstract:*The most common problem in agricultural industry is the contamination of corn with zearalenone.Zearalenone may cause humans and animals intoxications. It is often a cause of the disruption the breeding process with consequent economic losses. The aim of this work was to determine the incidence and concentrations of zearalenone (µg/kg) in corn samples using enzyme-linked immunosorbent assay (ELISA). Incidence of zearalenone in corn samples achieved 46.4 % (13 maize samples) with concentrations range 69.897 – 1531.617 µg/kg and average value 399.578 µg/kg. The detected levels of zearalenone did not exceed the maximum acceptable limits of 3,000 µg/kg.*

I. INTRODUCTION

The economic importance of corn cultivation (*Zea mays*) is mainly related to the provision of human and animal nutrition. However, corn is also used for industrial purposes (in the starch, fat, distilling, chemical or milling industries and for the production of bioethanol or biofuel). Of the total world production, a substantial part of corn is mostly used for animal feed. Corn is a highly concentrated carbohydrate feed suitable for feeding all types of livestock and is the main component of compound feed for poultry and pigs. Intensive cultivation of corn also carries certain risks. Among other things, this is the contamination of corn with microscopic filamentous fungi, which can occur during plant growth in the field or during grain storage[1].

The most important field fungi are representatives of the genera *Fusarium*and*Alternaria* and the most common storage fungi are species of the genera *Penicillium* and *Aspergillus* [7]. *Fusarium* fungi have been found to colonize more than 50% of corn prior to harvest [10]. In addition to the degradation of corn due to reduced nutritional properties of the grain, fusaria are able to synthesize secondary metabolites, mycotoxins. Important *Fusarium* mycotoxins are trichothecenes (deoxynivalenol, nivalenol, T-2 toxin), zearalenone andfumonisins[6].Zearalenone (ZEA), also known as F-2 toxin, is a secondary metabolic product of microscopic filamentous fungi of the genus *Fusarium*, mainly *Fusariumgraminearum*, but also other species such as *Fusariumeqiuseti*, *Fusariumcrookwellense*, *Fusariumculmorum*, *Fusariumnivale*, *Fusariumroseum*, *Fusariumsporotrichioides* and others[16].

Zearalenone is a non-steroidal mycoestrogenwith a chemical structure similar to steroid hormonewhich ensures its ability to bind to the intracellular estrogen receptors of the uterus, hypothalamus and pituitary gland[2]. Zearalenone acts as an estradiol agonist and partial antagonist, inhibits follicle-stimulating hormone secretion and prevents ovarian follicle maturation in the preovulatory phase[8]. The estrogenic effects of zearalenone cause not only reproductive disorders in animals but also hyperestrogenic syndrome in humans[13]. Pigs are most susceptible to zearalenone intoxications compared to other animal species. Typical clinical signs of intoxication are edema and hyperemia of the vulva in sexually immature sows [5].Persistent corpus luteum, anestrus and pseudogravidity may occur in sows if zearalenone is present in the feed in concentrationsbetween 3,000 and 10,000 µg/kg. ZEA at concentrations above 30,000 µg/kg in feed can cause early embryonic death if given to the animal within 1 to 3 weeks after fertilization[11]. In addition to genital pathological effects, zearalenone can have hepatotoxic, hematotoxic, immunotoxic and genotoxic effects[17].

The aim of this work was to determine the incidence and levels of zearalenone (µg/kg) in corn samples using the enzyme-linked immunosorbent assay (ELISA).

II. Materials and Methods

The incidence of zearalenone was detected in 28 samples of corn after harvest in 2018 (Tajba a. s., Čečejovce, Slovak Republic). The analysis was performed using a commercial Veratox for zearalenone kit (Neogen Corporation, USA). The samples were prepared as follows:25 ml 70% methanol was added to 5 g of the ground sample. The samples were shaken on an orbital shaker (Orbital Shaker - Biosan) for 3 minutes and filtered through Whatman 1 filter paper. After dilution with distilled water 1: 5, the samples were prepared for quantification using an ELISA kit. The resulting zearalenone concentrations (µg/kg) were read and evaluated using ELISA reader (Dynex Technologies, Inc., Virginia, USA).

III. Results and Discussion

The occurrence of zearalenone in the analyzed corn samples is presented in Tab. 1. Out of a total 28 samples, zearalenone was confirmed in 13 samples, representing an incidence 46.4%.Zearalenone levels in examined samples ranged from 69.897 µg/kg to 1531.617 µg/kg and the average ZEA concentration was 399.578 µg/kg. The detected levels of ZEA did not exceed the maximum limits of 3,000 µg/kg.

Table 1.Incidence of zearalenone in corn samples (µg/kg)

Cereals	n/n*	I (%)	Concentrations of ZEA (µg/kg)	Average value (µg/kg)
Corn	28/13	46.4	69.897-1531.617	399.578

Note: n – total number of examined samples, n* – number of samples with zearalenone, I – incidence of zearalenone, ZEA – zearalenone.

Corn is one of the cereals and they are a suitable substrate for the growth of microscopic filamentous fungi. The presence of micromycetes in cereals and environmental factors such as temperature and humidity are essential for mycotoxin synthesis [14].Zearalenone is an important mycotoxin that poses a threat to human and animal health.

In theexamined samples, zearalenone occurred in 13 samples with an incidence of 46.4%, in the concentration range of 69.897 - 1531.617 µg/kg. A higher percentage of corn contamination by zearalenone was confirmed in samples in Croatia, where the incidence of ZEA was up to 84%, but the concentration range (0.4 - 39 µg / kg) was lower than in the samples examined [3].

Similarly, Pleadin et al. (2012) found a higher incidence of zearalenone (88%) in corn samples from Croatia with concentrations range from 2 to 5,110 µg/kg [12].The incidence of ZEA in samples from Switzerland was 79%, ranging from 16 to 1,260 µg/kg [4].Lower contamination with zearalenone (8%) was recorded by Manova and Mladenova (2009) in samples from Bulgarian corn and Tabuc et al. (2011) in corn from Romania (32%) [9,15].The maximum concentration of zearalenone in corn samples in Bulgaria reached up to 4050 µg/kg[9].In monitoring the content of mycotoxins in feed, the Slovak Republic follows Directive 2002/32/EC on undesirable substances in feed and Commission Recommendation No. 576/2006/EC on limits for the content of mycotoxins

in feedingstuffs. The maximum level for zearalenone in corn by-products is 3,000 µg/kg. Zearalenone concentrations in the examined corn samples did not exceed the maximum limit.

IV. Conclusion

To ensure the production of quality agricultural crops, constant control is needed. This inspection begins at the time of crop growth in the field, during harvesting and also during storage. Regular monitoring of the incidence of microscopic filamentous fungi and their secondary metabolites can reduce the negative impact on livestock health. To eliminate the occurrence of microscopic fungi and mycotoxins various physical, chemical and biological methods are currently used. In addition to the use of decontamination procedures, good agricultural practice should be followed (efficient crop rotation, choice of suitable variety/hybrid, optimal sowing plan, adequate soil preparation and treatment, cultivation, collection, storage and crop transport).

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