

UBIQUITY OF TOXIGENIC FUNGI AND MYCOTOXINS IN ANIMAL FEEDS IN REPUBLIC OF SERBIA

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Abstract: Climatic conditions and growing of grain on large areas in Republic of Serbia are suitable for development of numerous toxigenic species, such as *Fusarium* spp., *Aspergillus* spp. and *Penicillium* spp., and resulting from this is frequent incidence of animal feed contamination by their toxic products. In Republic of Serbia, the most frequent fungi determined in animal feed are those from *Fusarium* genus, as well as their mycotoxins. Of *Fusarium* species the most frequent one is *F. graminearum*, and of toxins zearalenon, in maize or wheat grains, which are the main raw material in production of animal feeds. Development of this fungi and bio-synthesis of zearalenon most often depend on period of rains in the third decade of May when wheat is in the blossoming pheno-stage or on ample precipitation and low temperatures at the end of summer or beginning of autumn during sensitive pheno-stage of maize growing. Aflatoxins are rarely isolated in Republic of Serbia, but there are conditions for their increased presence in imported feed components. Natural occurrence of ochratoxin A is more frequent than incidence of aflatoxins in climatic conditions of Republic of Serbia. Presence of mycotoxins produced by species of genera *Fusarium*, *Aspergillus* and *Penicillium* indicates potential risk of incidence of mycotoxicosis, especially in younger animal categories. For the purpose of protection of health of animals, realization of profit and high productivity in livestock production, it is necessary to explain factors which can cause animal intoxication, and to identify toxins and develop methodology for assessment of the potential toxicity of animal feed.

Key words: animal feed, toxigenic fungi, mycotoxins

Introduction

The significant advance in intensive animal production systems is at once the cause and the consequence of the increase in grain production. Production of poultry and swine, in particular, requires a large amount of grain to fulfil their dietary needs. For this reason grain production increases every year; and following

harvest, most of the grain is stored until utilized. Fungi (mold) growth in grain is a normal occurrence in both the field and in storage. Fungi growth can spoil the nutritional aspects of the grain and also result in secondary metabolites that are highly toxic to animals, humans, and plants (Santin, 2005).

Mycopopulations which develop in the field contaminate plants and produce mycotoxins before harvesting (field fungi), whereas mycopopulations in storages contaminate plant products after harvesting (storage fungi), although in majority of cases they are same fungi species in both groups. Fungi from genera *Fusarium*, *Alternaria* and *Cladosporium* are mainly active in the field, whereas *Penicillium* and *Aspergillus* spp. are more active in conditions of storage spaces (Scudamore, 1993). At the same time, species which belong to genera *Fusarium*, *Aspergillus* and *Penicillium* are the most significant and most frequent toxin producers (Škrinjar et al., 2008). Although, in Republic of Serbia, species of *Alternaria* genus develop mostly on wheat grain (Lević et al., 2004), from the toxicological aspect the most important are species of *Fusarium* genus (Bočarov-Stančić, 1996). The contamination of crops in the field by mycotoxins is a combination of many factors, such as: the virulence of the infecting pathogens; the time of harvest, related to the mycotoxins concentration cycle; innate resistance of the crop to fungal infection; stresses: eg. soil salinity, water, insect attack, mineral deficiency, pollution; plants inherent ability to degrade mycotoxins enzymatically; types of mycotoxin produced (Harley, 1997).

Spores from moldy hay, silage, brewer's grain and suger-beat pulp may be inhaled or consumed by animals with deleterious effects termed „mycosis” (D’Mello, 2004). The latter may occur in cattle as a result of systemic transmission and subsequent proliferation in placental and foetal tissue.

Mycotoxins represent group of structurally different secondary fungi metabolites which are most frequent contaminants of different grains and other feed components, such as alfalfa hay, sunflower and soy bean meal, etc. (Harley, 1997). Maize and cereal crops with relatively high share in livestock feeds represent potentially high risk for health and production of livestock (pigs, poultry and cattle, since these plant species are very sensitive/susceptible to toxigenic *Fusarium* species and are often contaminated with fusariotoxins. For humans, food based on contaminated plants and products of animal origin, such as milk, cheese and meat products, represent the greatest risk of presence of mycotoxins (Lević, 2008). On livestock farms in Vojvodina, incidence of high level of fusariotoxin zearalenon (ZEA) was determined in samples of maize, soy bean and sunflower flour, imported to Republic of Serbia in period from 1996 to 2001 (Jajić et al., 2001).

Mycotoxins can cause health disorders in all animal species, and effects are mainly noticeable in high yielding animals in farm housing system since the consumption of concentrated feeds and/or food is significantly higher. Changes

caused by mycotoxins depend on species and amount of mycotoxins in food, duration of their intake into organism, as well as on genetic (specie, breed, strain of animal), physiological (category, age, nutrition, disease) and exterior (climatic conditions, housing) factors (*Sinovec et al., 2000*).

Studies of the micro-biological quality of samples of feed for different species and categories of animals, collected on the territory of Republic of Serbia, indicate that livestock feed is most often contaminated with fungi of following genera: *Fusarium* (51.4-84.3%), *Aspergillus* (54.4-79.2%), *Penicillium* (30.9-68.1%), as well as *Mucor* spp. and *Rhizopus* spp. (*Krnjaja et al., 2007b, 2008bcd*). According to Serbian legislation (*Official journal of SFRY, 1990*), investigated livestock feed was not compliant in 6.9-14.8% of samples for young categories of animals, and 1.9-15.3% of samples for older animal categories (*Krnjaja et al., 2007b, 2008bcd*).

In Republic of Serbia, based on study of incidence of fungi on stored maize, intended for nutrition of animals, the period from June to October is the most critical for preservation of the quality of stored maize (*Krnjaja et al., 2007a*). In that period, number of present species (8 to 14 present of total 17 identified fungi genera) and frequency of fungi were the highest, especially of toxigenic species of the *Fusarium* (43.5-62.5%) and *Penicillium* (10.0-33.5%) genera. During autumn, from samples of feed for dairy cows, the widest spectrum of fungi species was isolated and the most present were species of *Aspergillus* genus (68.0%), whereas *Penicillium* species were mostly present in summer (94.0%) and winter period (68.0%) (*Škrinjar et al., 2008*). According to these authors, during spring period the presence (56.0%) of species from genera *Fusarium*, *Mucor* and *Penicillium* was equal.

For the purpose of achievement of conditions for high quality and high productive livestock production in Republic of Serbia, in this paper a review of factors is given which influence the presence of toxigenic fungi and their mycotoxins in animal feed, as well as review of control measures for reduction of mycotoxin production.

Species of *Fusarium* genus and their mycotoxins

In Republic of Serbia, species of *Fusarium* genus are the main causers of maize and cereal grain disease, which often results in decrease of yield, diminishing of technological qualities and contamination of plant and animal products with mycotoxins (*Balaž et al., 1997; Lević et al., 2004; Stanković et al., 2008a*). From maize grain approx. 30 different species of genus *Fusarium* were isolated. Species *F. graminearum* Schwabe is the most significant pathogen in wheat as well as maize (*Bagi et al., 2000; Lević et al., 2001*). Except *F. graminearum*, from maize grain often the following were isolated: *F.*

verticillioides (Sacc.) Nirenberg, *F. subglutinans* (Wollenw. & Reinking) Nelson, Toussoun & Marasas (= *F. moniliforme* Sheldon) and *F. proliferatum* (Matsushima) Nirenberg, and in lower percentage *F. oxysporum* Schlecht., *F. sambucinum* Fuckel and *F. poae* (Peck) Wollenweber (Lević et al., 2001; Krnjaja et al., 2007a). European corn borer is the pest most present in Republic of Serbia, which can increase the contamination of the maize ear with species *F. verticillioides* up to 63.1% (Lević et al., 2004).

In previous years, in wheat grain species *F. graminearum* or *F. culmorum* (W.G. Smith) Saccardo were mainly isolated, but in recent years, beside *F. graminearum*, more often *F. poae* and *F. verticillioides* are isolated, and slightly less *F. proliferatum*, *F. subglutinans* and *F. sporotrichioides* Schrb. (Lević et al., 2004, 2009; Krnjaja et al., 2006; Stanković et al., 2007b; Krnjaja et al., 2008a). In 2005, in wheat grain, for the first time *F. langsethiae* Torp & Nirenberg was isolated (Lević et al., 2008b), which is also very toxigenic species (Bočarov-Stančić et al., 2008).

In analysis of food samples for different animal species and categories the presence of *F. verticillioides*, *F. subglutinans* and *F. proliferatum* (Krnjaja et al., 2007b; Krnjaja et al., 2008b; Škrinjar et al., 2008; Lević et al., 2009) was most often established, especially of *F. verticillioides* (to 46,3%) (Krnjaja et al., 2008b). In sunflower meal, of *Fusarium* species the following were most frequent: *F. sporotrichioides*, *F. subglutinans* and *F. verticillioides* (Bočarov-Stančić, 2006).

Toxigenic species *F. oxysporum*, *F. solani*, *F. equiseti*, *F. proliferatum*, *F. avenaceum*, *F. tricinctum*, *F. sporotrichioides* and *F. graminearum* were determined by Krnjaja et al. (2002) subsequent to isolation of pathogens from diseased alfalfa plants from four locations in Republic of Serbia. In seed of six alfalfa cultivars and three red clover cultivars, also in high and relative high percentage, following toxigenic species of *Fusarium* genus were isolated: *F. verticillioides*, *F. proliferatum*, *F. oxysporum*, *F. solani* (Mart.) Appel & Wollenw. and *F. subglutinans* (Krnjaja et al., 2003, 2004).

Zearalenon (ZEA). So far over 300 different mycotoxins have been identified, of which especially important are fusariotoxins, zearalenon, T-2 toxin, deoxynivalenol and fumonisins (Marasas, 2000). Zearalenon (ZEA) or F-2 toxin is known world wide as mycotoxin causing estrogen syndrome (estrogenism) in pigs. Incidence of zearalenon in nature is caused by high air humidity and low temperatures. Of zearalenon derivatives the most important are alfa- and beta-zearalenol. Zearalenon is primarily produced by species *F. graminearum*, which causes rotting of maize root, stem and ear/grain. In significantly smaller quantities, zearalenon can also be produced by *F. semitectum* Berk & Rav., *F. oxysporum*, *F. verticillioides*, *F. subglutinans*, *F. solani*, etc. (Meronuck and Concibido, 1996).

Lević et al. (2004) stated that in research carried out in eighties in Republic of Serbia, level of ZEA in maize varied from 200 to 7000 $\mu\text{g kg}^{-1}$ in numerous

samples with level of mycotoxins above the allowed limit. Bio-synthesis of ZEA in Republic of Serbia was most often established in species *F. graminearum*, in years with ample precipitation and low temperatures at the end of summer and beginning of autumn (Lević *et al.*, 2004). Kordić *et al.* (1990) established in forage mixtures for gilts, pregnant sows and sows in lactation from two pig farms 35.0% of samples with ZEA whose amount varied from 200 to 1100 $\mu\text{g kg}^{-1}$. In year 1991, 50-70 $\mu\text{g kg}^{-1}$ ZEA in samples of maize grain was established, collected from different locations in Republic of Serbia and which displayed symptoms of late contamination (Lević *et al.*, 1993). In wheat samples collected in period 2005-2006, natural incidence of ZEA was established in 62.5% of samples (Stanković *et al.*, 2008a). According to EU regulations relating to maximum allowed amount of mycotoxins in human nutrition, 41.2% of studied samples had higher concentration of ZEA than allowed for consumption in non-processed form, and in 11.9% for production of bread flour and baby food.

Trichothecenes. Trichothecenes are group of mycotoxins with over 150 different but structurally similar compounds which inhibit synthesis of proteins in eukaryotes causing diseases in humans and animals. They are divided into four groups: A, B, C and D (Ueno, 1983), of which the most frequent and most significant in agriculture are those from groups A and B. Trichothecenes are produced by various fungi species which belong to different genera, such as: *Trichothecium*, *Stachybotrys*, *Myrothecium*, *Cephalosporium*, *Trichoderma*, *Penicillium*, *Fusarium* and other. However, the most trichothecenes have been isolated from cultures of fungi species of *Fusarium* genus. First trichothecene was isolated in 1848 from culture of fungi *Trichothecium roseum* (Persoon) Link ex S.F. Gray, from which the term/name of this group of mycotoxins derives. T-2 toxin and diacetoxyscirpenol (DAS) from group A and deoxynivalenol (vomitoxin, DON) from group B are most isolated and identified trichothecenes in agricultural products contaminated with *Fusarium* species. Low temperatures, high air humidity influence increased production of these mycotoxins.

Trichothecenes weaken the immune system of mammals in a way that they modify through immune cells immune responses and cause damage of other tissues (Meronuck and Concibido, 1996). Individually or in combination, trichothecenes can cause mycotoxicosis in animals, septic angina (ATA) in humans and other disorders. As main causes of these occurrences mainly DAS and T-2 toxin are stated (Joffe, 1974). Over 20 species of *Fusarium* genus, which are aggressive pathogens and have wide spectrum of hosts, were described as producers of trichothecenes. Among them *F. sporotrichioides* and *F. poae* are the most often producers of T-2 toxin and DAS, whereas *F. crookwellense* Burgess, Nelson & Toussoun, *F. culmorum*, *F. graminearum* and *F. sambucinum* most often produce DAS and DON (Meronuck and Concibido, 1996).

Natural incidence of trichothecenes of type A, such as T-2 and DAS toxin, are very important for Republic of Serbia. So, for instance, it was established that naturally dried maize, which is the most present method of drying in Republic of Serbia, contained 250-1750 $\mu\text{g kg}^{-1}$ of T-2 toxin and 500-2000 $\mu\text{g kg}^{-1}$ of DAS toxin, and artificially dried maize contained significantly lower level of these mycotoxins, 250-750 $\mu\text{g kg}^{-1}$ (T-2) and 250 $\mu\text{g kg}^{-1}$ (DAS) (Lević et al., 2004). Investigation by Stanković et al. (2008b) show that in 14.8% of samples of wheat grain, 2005-2006 crop, were naturally contaminated with higher level of DON compared to allowed limit for utilization in non-processed form, in 3.7% for production of paste and in 37.0% for production of baby food.

Fumonisin. Fumonisin is a group of structurally similar mycotoxins which were isolated for the first time from cultures *F. verticillioides*, one of the most frequent maize contaminating species. Other species of genus *Fusarium* which produce these mycotoxins are *F. proliferatum*, *F. anthophilum* (A. Braun) Wollenw., *F. dlamini* Marasas, Nelson & Toussoun, *F. napiforme* Marasas et al. and *F. nygamai* Burgess & Trimboli (Thiel et al., 1991, Nelson et al., 1993). Fumonisin is grouped in four series: A, B, C and P. The most present fumonisin and directly connected to pathogenic effects are fumonisin of B (FB₁, FB₂, FB₃, FB₄) and A series (FA, FA₁ and FA₂) (Meronuck and Concibido, 1996). Studies have shown that less than 100 $\mu\text{g kg}^{-1}$ of body mass daily is sufficient to cause toxic effect in different animal species, and less than 1 $\mu\text{g kg}^{-1}$ of body mass of daily intake of FB₁ for humans (Petersen and Thorup, 2001, loc. cit. Dilas et al., 2003).

There are only few data on incidence of fumonisin in Republic of Serbia in relation to frequency of isolation of fungi species which produce them. In wheat samples, presence of fumonisin (FB₁ and FB₂) was determined in concentration of 250-640 $\mu\text{g kg}^{-1}$ (Protić, 2000). Presence of FB₁ in concentration of 45-70 $\mu\text{g kg}^{-1}$, was determined in two of 15 samples of maize harvested in 2002 and 450 $\mu\text{g kg}^{-1}$ in one of 5 samples of soy bean flour from import (Dilas et al. 2003). Considering high concentration of FB₁ (>5.000 $\mu\text{g kg}^{-1}$), wheat of the 2005-2006 crop only in 25.9% cases could have been used in human nutrition (Stanković et al., 2008a,c).

Species of genera *Aspergillus* and *Penicillium* and their mycotoxins

In Republic of Serbia, fungi of genera *Aspergillus* and *Penicillium* are often isolated in food samples for different species and categories of animals, as well as from maize grain after harvest or during storage (Krnjaja et al., 2007a,b, 2008b,c,d). According to data presented by Krnjaja et al. (2007b, 2008d) *A. flavus* Link is the most often isolated species in different livestock foods, whereas in lower

percentage *A. fumigatus* Fresenius, *A. ohraceus* Wilh and *A. niger* van Tiegh were also isolated.

Moldness of the maize ear is caused by several species of the genus *Penicillium*. These species adapt very well to different conditions of the environment, and symptoms can be different – from internal discolouration (“blue eye“) of the germ to full covering of the maize ear with blue-green mycelia.

Moldness of maize ear of type aspergillosis is most often caused by three species of genus *Aspergillus*: *A. flavus*, *A. parasiticus* Spear and *A. glaucus* Link ex Grey. Similar to *Penicillium* species, also *Aspergillus* spp. are very good adapted to different conditions of storage, especially in regard to lower air humidity. Disease starts at the top of maize ear, or it follows the tracks left by insects, and symptoms are noticeable in the form of grey-green powdery mycelia. Hot and dry summers favour the development of disease (*Stanković et al., 2007a*).

Aflatoxins. The aflatoxins are a group of closely related, highly toxic, mutagenic and carcinogenic compounds produced primarily by *A. flavus* and *A. parasiticus*. Almost all strains of *A. parasiticus* are toxigenic, and aflatoxin synthesis in *A. flavus* varied considerably depending on the strain. Contrary to the opinion that aflatoxins are secondary metabolites exclusively of the stated molds, there are opinions that there are also other species (*A. niger*, *A. ruber* Thom and Church, *Penicillium citrinum* Thom, *P. digitatum* Sacc., *Rhizopus* spp., *Mucor mucedo* Fresenius) with ability of aflatoxin synthesis, although only in traces (*Resanović, 2000*). There are 4 naturally occurring aflatoxins B₁, B₂, G₁, G₂ (thus designated because of the colour the emit, blue and green under UV light). Aflatoxins have a high potential to contaminate animal feeds that were grown or stored in an environment favourable for the growth of the fungi. Aflatoxin contamination of maize and other commodities has been and continues to be a major problem in many parts of the world (*Meronuck and Concibido, 1996*). The highest levels of aflatoxin are formed in plant products which are visibly damaged and infected, and poorly stored, badly harvested crops are still the most likely to be contaminated with dangerously high levels of aflatoxin. However, it is most often the relatively low water content present in stored products that creates an environment uniquely suited to the growth of the partially xerophilic species of both *Aspergillus* and *Penicillium* to the extent that both genera almost totally dominate the fungal flora of such environments (*Harley, 1997*). Aflatoxin B₁ was the first mycotoxin isolated from the food which caused death of 100.000 turkeys in 1960 in England. Aflatoxins have been determined world wide in different types of animal foods, and their quantity varies depending on numerous factors. There is great difference in frequency of contamination of livestock food in particular years. In favourable, suitable years, fungi synthesize aflatoxins in 2 days at the temperature between 20 and 40°C and humidity of over 13%. AB₁ is carcinogenic and hepatotoxic. All species and categories of domestic animals are susceptible and

sensitive to aflatoxins, also poultry, laboratory animals and fish. The most resistant are sheep and rabbits. Younger animals are more sensitive than older ones, gravid than non-gravid animals, and males than females (Rajić, 2000). Škrinjar et al. (1992) published that some samples of food for dairy cows were contaminated with AB₁ and AM₁ (5-16 µg kg⁻¹), but that none of the analyzed milk samples was contaminated with these aflatoxins. Acute signs, when observed, might include anorexia, depression, ataxia and epistases. Chronic primary mycotoxicosis resulting from low level dietary intake of aflatoxin have been well documented; reduced weight gain, reduced milk yield, reduced feed intake and feed conversion, icterus and decreased appetite (Meronuck and Concibido, 1996; Harley, 1997).

Ochratoxins. These mycotoxins are bio-synthesized by fungi of genera *Aspergillus* and *Penicillium*. There are several groups of ochratoxins: A, B, C, alfa, beta. In Republic of Serbia, of special importance are ochratoxin A (OA) and ochratoxin B (OB) (Rajić, 2000). Ochratoxin A is produced primarily by *A. ochraceus* and *P. verrucosum* Dierckx on a variety of substrates, including cereal grains and oil seeds. Mycotoxin production is optimised at higher temperatures (12-37 °C) for *A. ochraceus*. *P. verrucosum*, on the other hand, has better mycotoxin production at the cooler temperatures (4-31°C). Both organisms are classified as storage of OA under poor storage conditions for commodities that provide optimum conditions, e.g. increased moisture for enhanced fungal development and mycotoxin production. Animal studies have shown OA to be a potent nephrotoxin, immune suppressant, teratogen, carcinogen as well as a potent foetoxic agent. In most animals studied, the target organ of OA is the kidney. It causes necrosis of the proximal tubules. Consumption of feeds contaminated with OA results in nephropathy in animals, especially in swine and poultry (Harley, 1997; Manning, 2005).

In maize and sunflower flour samples, Mašić et al. (2003) established presence of OA and AFB₁ in average concentrations of 36-37 to 69-78 µg kg⁻¹. In samples of food for poultry presence of OA in concentration of 140 to 165 µg kg⁻¹ was established (Mašić et al., 2003).

Measures for safe storing of animal food

Control of mycotoxin bio-synthesis in practice can be divided into two phases: prevention of fungi development and of production of mycotoxins and detoxication of existing mycotoxins in animal food. Prevention of food contamination by toxicogenic molds is the most rational and economically justified method for prevention of potential consequences of the action of their metabolites on animal and human health.

For the purpose of prevention of mycotoxin bio-synthesis, it is primarily necessary to take measures which prevent development of fungi in the field and

storage spaces. These measures include: growing of genotypes resistant to toxigenic fungi species and insects, optimal agro-technical measures, health control of the seed, harvest in full maturity, separation of seed with pathological changes and maintenance of optimal conditions for storage of harvest products. General principle is to store only dry grain which is cooled, dried to approx. 13% of moisture, intact, healthy and purified of foreign ingredients or substances, in storage room whose structure and organization provide preservation of the quality before consumption (*Stanković et al., 2007a; Lević et al., 2008a*).

When foods and/or feeds have been contaminated with mycotoxins, measures are implemented which enable elimination of mycotoxins by detoxication or degradation into less toxic or completely non-toxic compounds by process of detoxification. Detoxication represents procedure by which toxic substances are removed from food by selective solvents or procedures, whereas detoxification is defined as conversion of toxic substances into non-toxic derivatives (*Sinovec et al., 2000*).

There are numerous methods which can be used to carry out decontamination of livestock food contaminated with mycotoxins. Different physical and chemical methods are recommended for detoxification of livestock food contaminated with mycotoxins. However, only few of them (for instance destruction by ammonia treatment, ammonization) are accepted for implementation in practice. By degradation of mycotoxins using selective micro-organisms, mycotoxins are removed without significant losses of the nutritive value of animal food. Fermentation is one of the oldest, easiest and cheapest ways of food preservation. For this purpose lactic acid bacteria and yeasts are used (*Biernasiak, 2006*).

In practice, often in animal food different materials are used which adsorb mycotoxins from food in digestive tract of the animal. Zeolite and clay minerals adsorb at their surface with more or less efficiency different mycotoxins. These minerals belong to group of aluminosilicate minerals. Their efficiency for mycotoxin adsorption depends on the capacity of adsorption, crystal structure and superficial electricity on one side, as well as on traits present in mycotoxins on the other (*Sinovec et al., 2006*). The best known and most efficient preparations of mineral zeolite are Min-a-Zel and Min-a-Zel Plus. These products gave the best results, from the aspect of number and species of mycotoxins being adsorbed by these preparations, as well as from the aspect of critical mass of the organic phase which allows uninterrupted application in food for animals (*Tomašević- Čanović et al., 2001*).

Recently, different biological adsorbance are applied which competitively bind mycotoxins and in this way prevent their harmful effect. Modified glucoman obtained from cell walls of *Saccharomyces cerevisiae* yeast (preparation Mycosorb) successfully reduces certain individual as well as combined harmful effects of aflatoxins, ochratoxins and T-2 toxins (*Devegowda and Murthy, 2005*).

Conclusion

Fungi and their mycotoxins have significant economic and commercial impact, in that both the productivity and nutritive value of the infected cereal and forage is affected. Contamination by molds affects both the alimentary value and organoleptic characteristic of feed and entails a risk of toxicosis.

Undoubtedly, mycotoxicoses of animals occur, affecting livestock, health and production efficiency, however the subtle effects which occur are difficult to assess regarding economic losses. Efforts continue in determining the occurrence of mycotoxins in foods and feed through diagnostic procedures, surveys and epidemiological studies.

Imperative to the task of minimising mycotoxin production and contamination of the food supply is the development of methods to control their formation, or the development of newer methods to detoxify or decontaminate the affected commodities safely.

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Prisustvo toksigenih vrsta gljiva i mikotoksina u stočnoj hrani u Republici Srbiji

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Rezime

Klimatski uslovi i gajenje žita na velikim površinama u Republici Srbiji pogoduju razvoju brojnih toksigenih vrsta, kao što su *Fusarium* spp., *Aspergillus* spp. i *Penicillium* spp., i kao rezultat toga je i česta kontaminacija hrane za životinje njihovim toksičnim produktima. U Republici Srbiji su u hrani za životinje najčešće utvrđene gljive iz roda *Fusarium*, kao i njihovi mikotoksini. Od *Fusarium* vrsta najčešća je *F. graminearum*, a od toksina zearalenon, bilo u zrnju kukuruza ili pšenice koje su najčešće sirovine za stočnu hranu. Razvoj ove gljive i biosinteza zearalenona najčešće zavise od kišnog perioda u trećoj dekadi maja kada je pšenica u fenofazi cvjetanja ili od obilnih padavina i niskih temperatura pri kraju leta i početkom jeseni kada je osetljiva fenofaza kukuruza. Aflatoksini su retko izolovani

u Republici Srbiji, ali postoje uslovi za veće prisustvo prilikom uvoza komponenti hrane za životinje. Prirodna pojava ohratoksina A je češća od pojave aflatoksina u klimatskim uslovima Srbije. Prisustvo mikotoksina koje produkuju vrste roda *Fusarium*, *Aspergillus* i *Penicillium* ukazuje na potencijalni rizik od pojave mikotoksikoza, posebno za mlađe kategorije životinja. U cilju zaštite zdravlja životinja, ostvarivanja dobiti i visoke produktivnosti u stočarskoj proizvodnji, postoji potreba da se objasne faktori koji mogu prouzrokovati intoksikaciju životinja, kao i da se toksini identifikuju i razvije metodologija za ocenu potencijalne toksičnosti hrane za životinje.

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