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VETERINARY

Biological Toxicants of Alimentary Origin

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Abstract—The purpose of this research was to determine the degree of farm animal feed contamination with pathogenic microflora, microscopic fungi, and mycotoxins. Investigation of 16 types of farm animal feeds (barley, wheat, corn, pea, oat, grain mixture, scalpings, oilcakes, fish meal, meat-and-bone meal, combined feeds for pigs of different ages, combined feeds for poultry and cattle, feed additives, and premixes) from 175 farms of different regions of the Russian Federation in the period from 2006 to 2012 revealed the nature of their contamination with pathogenic microflora, microscopic fungi, and mycotoxins. This article provides methods of animal disease prevention when using feeds containing biological contaminants dangerous for animals' health.

Keywords: feeds, animals, contamination, pathogenic microflora, microscopic fungi, mycotoxins, monitoring

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INTRODUCTION

It is known that the main causes of animal diseases are improper husbandry, nutrition, and handling; infective and parasitic (invasive) diseases; and genetic predisposition for them. Among these factors, feeds and, especially, their quality are the most significant in the etiology of animal diseases. Nutrients contained in feed are lost as a result of disturbance of their production technology and storage conditions, which leads to a deterioration of the sanitary feed quality by microscopic fungi formed by toxins and agents of infectious and invasive diseases.

According to the literature data [1–3], 40–89.9% of feeds are affected by microscopic fungi, and, in 21–69.7% of them, microtoxins were revealed in concentrations dangerous to health. In farms with high animal morbidity, 42.1% of the investigated feed samples did not meet safety requirements for microbiological indicators; the excess of the maximum allowable concentration of mycotoxins was revealed in 10.4% of samples, and simultaneous feed contamination with two–four mycotoxins at concentration lower than MAC was established in 17.2% [4, 5].

Taking into account the widespread occurrence of feed infestation by mycoses and mycotoxins; their toxicity and carcinogenic, mutagenic, and embryotoxic effect; and the possibility of occurrence of epizootic diseases when feeds are infested by pathogenic microflora, it is very important to study the range of feed intoxication with agents of disease [6, 9].

The purpose of our research was to determine the degree of farm animal feed contamination with pathogenic microflora, microscopic fungi, and mycotoxins.

METHODS

In 2006–2012, 3620 samples of 16 types of farm animal and poultry feeds (barley, wheat, corn, pea, oat, grain mixture, scalpings, oilcakes, fish meal, meat-and-bone meal, combined feeds for pigs of different ages, combined feeds for poultry and cattle, feed additives, and premixes) were investigated from 175 farms of different regions in Russia; among them, 2546 samples were tested for pathogenic microorganisms, of which 680 were tested for total bacterization (QMA&OAMO (total quantity of mesophilic aerobic and optional anaerobic microorganisms), cfu/g; the species composition of microscopic fungi and the total number of fungi (TNF, U/g) were determined in 457 samples; the level of mycotoxins was determined in 3620 samples, including the determination of aflatoxin B_1 (2723 samples), ochratoxin A_1 (2675), T-2-toxin (3566 samples), zearalenone (3566 samples), and desoxynivalenol (DON) (2479 samples).

Selection of samples and their investigation were carried out according to generally accepted regulatory documents and GOSTs (Russian State Standards) on bacteriological, mycological, and mycotoxicological feed studies.

RESULTS AND DISCUSSION

In total, over the period under consideration, the pathogenic flora was revealed in 572 feed samples (20.1% of all the investigated samples); among them, 36.3% of grain mixture samples, 17.1% of barley samples, 26.7% of meat-and-bone meal samples, 5.6% of corn samples, 14.1% of samples of combined feed for pigs, a total of 40.1% of nongranulated samples, and

Species composition of pathogenic microflora isolated from feeds

Microorganism species	Isolation frequency, %	Microorganism species	Isolation frequency, %
E. coli	8.7	*Ps. aureginosa*	1.8
Salmonella spp.	2.7	*Serratia fonticola*	1.8
Cl. perfringens	1.4	*Cedecea lopagei*	2.3
C. diversus	36.5	*Erwinia uredovora*	1.4
C. freundi	30.1	*Edwarsiella hoshina*	0.9
C. amalonaticus	2.3	*Providencia tettgeri*	0.5
Klebsiella pneum.	6.4	*Enterobacteria asburia*	0.5
Pr. vulgaris	1.8	*Enterobacteria agglomeras*	0.9

12.3% of samples of combined feeds for poultry did not meet microbiological safety requirements. The degree of contamination with pathogenic microorganisms varied from 10.1 to 25% from year to year. Of 1089 isolated cultures, 219 were pathogenic for white mice. The species composition of pathogens is given in the table.

The mycological studies of feed grain (barley, wheat, corn, oat, and pea) revealed epidermal spore contamination in 100% of samples and subepidermal spore contamination in 84.5% of samples. The subepidermal spore contamination of affected grain was 100% in 43.1% of samples, from 50 to 99% in 31.4% of samples, and less than 50% in 25.5% of samples.

The total number of fungi (TNF) in 42.6% of grain samples exceeded 5×10^4 d/g (diaspores/gram), while in 57.4% of samples, it was less than 5×10^4 d/g. In granulated and nongranulated combined feeds for pigs, microscopic fungi were not isolated in 40.7% of samples; in 48.7% of samples, the TNF was less than 5×10^4 d/g; in 10.6%, it was more than 5×10^4 d/g, and microscopic fungi were found in 6.9, 86.2, and 6.9% of samples, respectively, in combined feeds for poultry. The high degree of subepidermal spore contamination of feed grain is evidence of a decrease in its nutritional value. In addition, grain color and odor were changed. The lower pore contamination of combined feeds with microscopic fungi than that of grain indicates the use of fungistatic preparations for combined feed production under conditions of combined plants (shops that supplied samples).

During the mycological examination, the microscopic fungi were isolated in 100% of cases for grain feeds, in 59.3% of cases for combined feeds for pigs, and in 83.1% of cases for poultry. The fungi isolated from feeds (concentrated feeds, rough feeds, hay, and silage) included *Aspergilium* spp. (26.5–60.7%), *Penicilinum* spp. (25.0–48.7%), *Fusarium* spp. (10.7–15.4%), *Alternatia* spp. (6.8–35.7%), *Mucor* spp. (40.2–50.0%), *Stachybotris* (0.0–3.4%), and other fungi (yeast-like fungi *Helmintosporum*, *Cladosporum*, etc.) (10.4–28.6%); the share of two or more simultaneously isolated fungi was 41.0–78.6%. The frequency of occurrence of mycotoxins (aflatoxin B_1, ochratoxin A_1, T-2-toxin, zearalenone, DON) was respectively 2.0, 22.6, 70.2, 66.0, and 100.0% in rough and succulent feeds; 1.3, 14.8, 76.4, 55.2–95.0% in combined feeds; 1.7, 23.1, 42.8, 48.6, and 91.9% in grain feeds; and 1.5, 15.2, 38.8, 46.5, and 89.5% in grain and food production wastes, which is 1.3, 17.6, 59.8, 53.2, and 93.3%, on average.

The mycotoxicological studies of 3620 samples of different types of feeds revealed a high degree of their contamination with mycotoxins. In the contaminated feeds, the concentration of aflatoxin B_1 was 1.1% in the volume of 10 μg/kg or more and 98.9% in the volume of less than 10 μg/kg; the concentration of ochratoxin A_1 was 10.6 and 89.4%, respectively; T-2 toxin concentration of 100 μg/kg or more was 28.9% and the concentration of less than 100 μg/kg was 71.1%; the zearalenone concentration of 35 μg/kg or more was 16.4% and the concentration of less than 35 μg/kg was 83.6%; the DON concentration of 1 μg/kg or more was 8.0% and the concentration of less than 10 μg/kg was 92.0%. During the study of feeds, one mycotoxin was found in 22.8% of samples, two mycotoxins were found in 43.5 samples, three mycotoxins were found in 26.8 samples, and four mycotoxins were revealed in 6.9% of samples. In addition, aflatoxin B_1, ochratoxin A_1, T-1 toxin, zearalenone, and DON were revealed in combination in 100, 96.8, 81.6, 83.8, and 72.5% of contaminated samples, respectively.

Rough and succulent feeds used as a stock for producing combined feeds are contaminated with microscopic fungi up to 100% of cases; among them, there are potential mycotoxin producers and agents of mycoses and mycotoxicoses. The degree of contamination of 16 types of feeds with mycotoxins under the conditions of the Central Chernozem Area has been 75–78% of the number of the investigated samples over the recent years, including 69.9% of grains of different cultures, 86.7% of rough and succulent feeds, and 88.2% of combined feeds and grain fodder. The dominant contaminants among the revealed mycotoxins are metabolites of fusarial microscopic fungi: DON 93.3%, T-2 toxin 59.8%, and zearalenon 53.2%;

ochratoxin A_1 was revealed in 17.6% and aflatoxin B_1 was revealed in 1.5% of the investigated samples. The concentration of mycotoxins in all the investigated feed samples exceeded MAC only in 9.6% of cases with respect to one of mycotoxins; however, two to four mycotoxins were simultaneously revealed in 76.8% of samples of contaminated feeds, which pose a real threat to animal health, especially the health of high-productive animals and offspring.

Taking into account the obtained data and the Foundations for State Policy in Insuring Chemical and Biological Safety in Russia for the Period up to 2010 and Further Prospect that were adopted by the Russian Government on April 7, 2004, the following measures should be taken to prevent the death of animals due to feeds contaminated with pathogenic microflora, microscopic fungi, and mycotoxins:

(1) Carry out systematical monitoring of the abovementioned agents of disease in objects of ecological interest, feeds, and agricultural and food industry;

(2) Regularly carry out sanitary-microbiological, mycological, and mycotoxicological monitoring of plant feeds and combined feeds in specialized farms;

(3) Use differently-based enterosorbents (aluminosilicate-, activated coal-, and toxin biotransformer-based enterosorbents), and integrated preparations (fungistat K, ecofiltrum, probiotic Laktur, etc.) for feed detoxication; and

(4) Carry out thermal treatment, radiation, and chemical agents (formic, acetic, and propionic acids, neutral anolyte, etc.) for disinfecting feeds from pathogenic microflora.

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