MYCOTOXINS - DAIRY CATTLE BREEDING PROBLEM. A CASE REPORT

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Abstract

The article aimed at drawing attention to the problem of mycotoxicoses, appearing in cattle and often undiagnosed because of lack of characteristic clinical signs. It described an outbreak of mycotoxicosis in one of the dairy-cattle herd in north-east Poland. In this case, DON, 3-Ac-DON, OTA, T-2 toxin, and ZEA were found in the feed and were considered as causative agents in a decrease in milk yield, occurrence of clinical symptoms of toxicosis, and death of some cows.

Key words: dairy cattle, mycotoxins, mycotoxicoses.

From the toxicological and economical point of view, five mycotoxin groups are currently significant worldwide. These are aflatoxins and ochratoxin A, produced mainly in storage conditions by Aspergillus and Penicillium fungi, and trichothecenes, zearalenone, and fumonisins produced by Fusarium species, contaminating cereals in the fields. Depending on dosage and exposition time to mycotoxins, animals’ intoxication may be acute, caused by high doses of mycotoxins intake or chronic, resulting from long term low dose of mycotoxin intake (15). Adult ruminants show a high ability to biodegrade mycotoxins, because bacteria and protozoa settling the rumen neutralise mycotoxins to less toxic compounds in so-called presystemic biodegradation (12). Calves are deprived of these abilities because of non-functioning rumen – therefore, they are more sensitive to mycotoxins. However, the assumption that rumen flora has unlimited detoxifying abilities is wrong. As studies show, high dosage and/or a high number of different kinds of mycotoxins, limit rumen flora population and as such generate more un non-degraded and still-toxic compounds, which consequently, by passing to further intestinal tract segments, are absorbed in the duodenum and then damage internal organs (7). The aim of this article is to call attention to the problem of mycotoxicoses, which appear in cattle and very often are undiagnosed because of the lack of characteristic clinical signs.

Case description

The case involved dairy cows of Black and White breed in one of the farms in north-east Poland. In a herd of about 60 animals a gradual decrease in milk production was observed. The animals converted feed to a lesser extent and in a few individuals complete reluctance was observed. Initially, self-limiting diarrhoea without the need for treatment appeared in some of the cows. Despite usage of feed with balanced composition regarding energy, proteins, and mineral compounds assisting productivity and maintenance needs, the number of sick animals increased. More and more persistent diarrhoea did not submit to pharmacological treatment. In clinical examination mottled and matt hair, dehydration, respiratory and cardiac insufficiency, joint effusion, ataxia, rumen atony, empty or in few cases filled with watery-green liquid rectum were observed. The eversion of rectum mucus was noted. Clinical signs of the disease concerned cows of high milk capacity. Despite intensive protective treatment, a few cows died. Post mortem examinations of the dead animals showed pulmonary oedema, blood extravasations under pericardium, liver friability, haemorrhagic inflammation of intestinal mucosa, extravasations under visceral peritoneum of the abomasum and reticulum, and reticulum with spleen adhesions.

Because of the suspicion of mycotoxin intoxication, samples of feeds were collected and examinations in respect of aflatoxin B1 (AFTB1), deoxynivalenole (DON), 3-acetyl-deoxynivalenole (3-
Ac-DON), ochratoxin A (OTA), T-2 toxin (T-2), and zearalenone (ZEA) were conducted. Clinical and anatomopathological examination results were obtained from the field veterinary surgeon taking care of the herd.

**Material and Methods**

**Samples.** The materials for mycotoxicological analyses were samples of supplementary feed mixture for dairy cows, hay, haylage, beet pool, and corn silage. Materials for biochemical examination were blood serum samples collected from three cows with clinical signs of the disease.

**Mycotoxins determination assays.** AFTB$_1$, OTA, T-2 toxin, and ZEA determinations were made with HPLC-FLD method (AflaTest$^\text{TM}$, OchraTest$^\text{TM}$, T-2 Test$^\text{TM}$ and ZearalaTest$^\text{WB}$, Instruction Manual, VICAM), and DON and 3-Ac-DON with HPLC-UV method (DonTest$^\text{WB}$, Instruction Manual, VICAM).

**Determination of blood serum biochemical parameters.** Levels of total protein, urea, creatinine, and direct bilirubin, and activity of aspartate (AST) and alanine (ALT) aminotransferases, and alkaline phosphatase (ALP) were determined by kinetic method with EPOLL-20 analyser (3).

**Results**

Results of AFTB$_1$, DON, 3-AcDON, OTA, toxin T-2, and ZEA determinations in different samples of cows’ feeds are shown in Table 1.

In none of the analysed feed samples the presence of AFTB$_1$ over the detection limit was found. DON was not found in hay and beet pool samples. 3-AcDON and T-2 toxin were also not found in beet-pool samples and OTA and ZEA were not found in haylage samples. The concentrations of particular mycotoxins in the analysed samples were as follows: DON - 50.0–3160.0 µg/kg, 3-Ac-DON - 21.0–430.0 µg/kg, OTA - 171.0–1980.0 µg/kg, and ZEA - 50.0–220.0 µg/kg. The highest concentrations of DON, 3-Ac-DON, OTA, and ZEA were found in supplementary feed mixture, where they were in the following concentrations: 3,160.0, 430.0, 1,980.0, and 220.0 µg/kg, respectively. Concentration range for T-2 toxin was from 134.0 to 771.0 µg/kg, and the highest level was found in hay samples.

The serum concentrations of total protein, urea, creatinine, and direct bilirubin, and the serum activity of AST, ALT, and ALP are shown in Table 2.

The activity of AST, ALT, and ALP in samples from three examined cows exceeded significantly reference values for this species. Activity ranges of the enzymes were as follows: AST from 227.9 to 257.6 U/I, ALT from 155.6 to 197.5 U/I, and ALP from 196.8 to 264.0 U/I. The highest AST activity of 370.0 U/I was determined in cow 2. In cow 3, the highest activity of ALT and ALP was found and it was 197.5 and 264.0 U/I, respectively. Bilirubin, creatinine, and urea concentrations in blood samples also exceeded the upper range of reference values for cattle. The urea concentration ranged from 19.0 to 34.0 mmol/L, creatinine from 211.0 to 262.8 µmol/L, and bilirubin from 2.9 to 3.8 µmol/L. Only the level of total protein in all analysed samples was within accepted norms.

<table>
<thead>
<tr>
<th>Table 1</th>
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<tr>
<td>Mycotoxin appearance in different samples of cows’ feed</td>
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<table>
<thead>
<tr>
<th>Sample</th>
<th>AFTB$_1$</th>
<th>DON (µg/kg)</th>
<th>3-AcDON</th>
<th>OTA (µg/kg)</th>
<th>T-2</th>
<th>ZEA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplementary feed mixture</td>
<td><em>nd</em></td>
<td>3,160.0</td>
<td>430.0</td>
<td>1,980.0</td>
<td>240.0</td>
<td>220.0</td>
</tr>
<tr>
<td>Hay</td>
<td>nd</td>
<td>nd</td>
<td>98.0</td>
<td>197.0</td>
<td>771.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Haylage</td>
<td>nd</td>
<td>50.0</td>
<td>137.0</td>
<td>134.0</td>
<td>nd</td>
<td></td>
</tr>
<tr>
<td>Corn silage</td>
<td>nd</td>
<td>70.0</td>
<td>21.0</td>
<td>171.0</td>
<td>220.0</td>
<td>50.0</td>
</tr>
<tr>
<td>Beet pool</td>
<td>nd</td>
<td>nd</td>
<td>nd</td>
<td>420.0</td>
<td>nd</td>
<td>190.0</td>
</tr>
</tbody>
</table>

*nd – not detected over the limit of detection

<table>
<thead>
<tr>
<th>Table 2</th>
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<tr>
<td>Biochemical parameters in blood serum samples</td>
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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Cow 1</th>
<th>Cow 2</th>
<th>Cow 3</th>
<th>Reference values*</th>
</tr>
</thead>
<tbody>
<tr>
<td>AST (U/L)</td>
<td>257.6</td>
<td>370.0</td>
<td>227.9</td>
<td>58-100</td>
</tr>
<tr>
<td>ALT (U/L)</td>
<td>155.6</td>
<td>182.5</td>
<td>197.5</td>
<td>25-74</td>
</tr>
<tr>
<td>ALP (U/L)</td>
<td>196.8</td>
<td>234</td>
<td>264.0</td>
<td>41-116</td>
</tr>
<tr>
<td>Total protein (g/dL)</td>
<td>5.5</td>
<td>6.7</td>
<td>5.8</td>
<td>5.1-7.1</td>
</tr>
<tr>
<td>Urea (mmol/L)</td>
<td>26.2</td>
<td>19.0</td>
<td>34.0</td>
<td>1.66-7.47</td>
</tr>
<tr>
<td>Creatinine (µmol/L)</td>
<td>211.0</td>
<td>256.5</td>
<td>262.80</td>
<td>88.4-183.0</td>
</tr>
<tr>
<td>Direct bilirubin (µmol/L)</td>
<td>2.9</td>
<td>3.2</td>
<td>3.8</td>
<td>0-2.7</td>
</tr>
</tbody>
</table>

Winnicka (16)
Discussion

Clinical signs of poultry aflatoxicosis, equine leukoencephalomalacia, zearalenosis, or swine pulmonary oedema are well known and described (11). Clinical signs of mixed cow mycotoxicosis are variable, not pathognomic, and are often not identical with the results observed during controlled intoxications with one mycotoxin. On the one hand, it is a result of so-called mycotoxins “conjugation” or “dissembling” (1), and on the other, the result of different kind of interactions between mycotoxins (additivity, synergism, potentiating, and antagonism) (2).

Rumen flora is the first-line defence against mycotoxins and it takes part in so-called presystemic mycotoxin biodegradation (11), aiming at mycotoxin degradation to less toxic compounds. It is not the case with fumonisins, which pass rumen not being degraded or ZEA, which is degraded to more oestrogenic α-zearalenol. Many mycotoxins showing antibacterial, antiprotozoal, and antifungal properties, modify rumen flora.

OTA causing mycotoxicological swine nephropathy is hydrolysed in the rumen to less toxic to cows ochratoxin α and phenylalanine. However, it was stated that cow’s feed naturally-contaminated with OTA at the level of 1,000 µg/kg of feed is the cause of feed-intake reluctance, diarrhoea, and kidney damage. It is combined with simultaneous citrinine occurrence, which is produced with OTA by the same Aspergillus species and increases significantly the toxicity of feed dosage.

Trichothecenes are a great threat to cattle and they are recognised as gastrointestinal toxins, which produce dangerous mucosal inflammations of the intestinal tract and damage to parenchymatous organs. Pier et al. (9) administering to cows diet containing 640 µg/kg of T-2 produced rumen and reticulum ulceration and haemorrhagic intestinal inflammation. DON in a concentration higher than 1,000 µg/kg of feed can decrease appetite (14, 17). T-2 toxin and DON, by changing levels of dopamine, tryptophan, and serotonin in the brain cause a decrease or lack in feed intake (10).

According to American data collected from over 300 dairy cattle herds (about 40,000 cows), DON decreased lactation and increased numbers of somatic cells in milk (6). Canadian studies on cows being in the first lactation showed that a diet containing DON at level from 2,600.0 to 6,500.0 µg/kg, caused 13% decline of milk production (5).

In monogastric animals (8) and in cows, ZEA causes different types of reproductive tract disturbances. Alpha-zearalenol, derivative of ZEA, is responsible for oestrus signs in immature cows, irregular periods in oestrus cycle, silent oestrus, foetus death, abortions, placental retention, and uterus and mammary gland inflammation. Trichothecenes present in feed increase oestrogenic activity of ZEA. Coppock et al. (4) by administering ZEA and DON to cows in 660 and 440 µg/kg dosage, apart from lower milk production, showed lowered appetite, diarrhoea, inflammatory lesions in the intestinal tract, and more infections in the reproductive tract.

Mycotoxins present even in diets well balanced in energy and proteins, leading to productivity and maintenance, are a great threat for cows. Some mycotoxins showing strong antimicrobial action, reduce rumen flora, limiting the efficiency of presystemic mycotoxins elimination. Dairy cattle are more sensitive to mycotoxins than beef cattle. It is connected to high milk production, drying period, parturition, and beginning of lactation, when risk of metabolic diseases is increasing. Released corticosteroids together with immunosuppressive action of mycotoxins decide about cows’ increased sensitivity to external infections and opportunistic infections, which make difficult the diagnosis of mycotoxicosis (13).

Diagnosis of cow mycotoxicosis is difficult, because, regardless of such signs as lower lactation or decreased animal condition in different periods, many non-specific clinical signs are observed. Mycotoxicosis diagnosis is complex and should consider results of clinical, biochemical, haematological, and pathomorphological examinations, and mycotoxicological analysis of the diet. In differential diagnosis, stress factors, primary infectious and parasitic diseases, and metabolic diseases connected with the quality and composition of diet should be also taken into account. In prophylaxis of cows’ mycotoxicoses, one should remember that the rumen does not have unlimited detoxifying properties and therefore feed, and especially corn and haylage, should be of high quality and not mouldy.

References

7. Kiessling K.H., Patterson H., Sandholm K., Olsen M.: Metabolism of aflatoxin, ochratoxin, zearalenone, and three trichothecenes by intact rumen fluid, rumen...