Deactivating the toxic effects of mycotoxins in dairy cattle

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Mycotoxins are secondary metabolites produced by filamentous fungi during the course of organic matter digestion. The actual cause of their occurrence is not fully understood but it is widely observed that mycotoxin problems are more pronounced in crops growing under cool, moist weather or drought-stressed conditions.

Such conditions are occurring more frequently all over the world. Dairy farmers, assuming that ruminants are largely resistant to mycotoxins, have neglected the negative effects of these metabolites on their cattle. This assumption, however, disregards a handful of critical factors crucial to modern dairy farming.

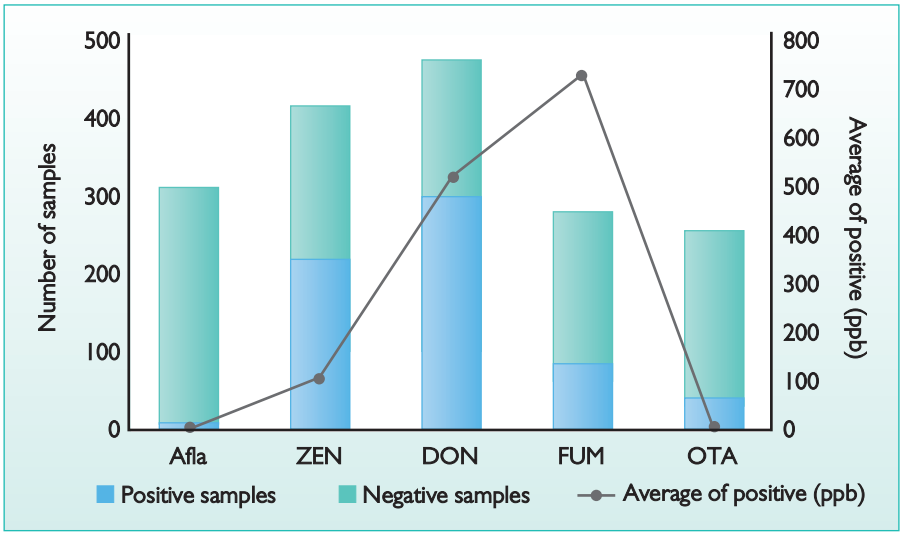

Fig. 1. Biomin worldwide mycotoxin survey. Analysis results for silage samples tested in 2012 and 2013. Fusariotoxins, such as zearalenone (ZEN), deoxynivalenol (DON) and fumonisins (FUM) were the most prevalent mycotoxins.

Cows fed complex diets

Ruminants require a good intake of roughage. These diets, which include concentrates and fibre sources such as hay, forage and silage expose the animal to greater mycotoxin risks. The interaction between mycotoxins often leads to synergistic effects where the negative effect of one mycotoxin is amplified by the presence of another mycotoxin. This is especially true in the case of fusariotoxins.

Fusarium graminearum and Fusarium culmorum are known to produce several different fusariotoxins under the same conditions, for example, zearalenone (ZEN) and deoxynivalenol (DON), which are also known to interact synergistically in the animal.

The assumption that mycotoxins remain inactive in the rumen depends on feedstuffs being retained in this 'compartment' long enough to allow complete degradation by rumen micro-organisms. But this is becoming more difficult to guarantee as animals are fed increasing quantities of feed in order to increase milk yields.

With large amounts of feed, passage rates are higher and less time is available for proper feed digestion. Mycotoxin degradation in the rumen is thus impaired.

Scientific studies demonstrate that not all mycotoxins are subject to enzymatic cleavage by rumen micro-organisms. Based on the results of Engel and Hagemeister (1978), only up to 42% of aflatoxins are rumen degradable; thus up to 58-100% may still be absorbed by the animal. Nonetheless, other scientists did not find a degradation of this mycotoxin in the rumen.

Fumonisins pass the rumen practically unaffected and zearalenone is converted into the more oestrogenic compound alpha-zearalenol. However, drastic changes in feed composition and a high percentage of protein-rich concentrates in the daily diet modify the cleavage capacity of rumen micro-organisms.

Rumen function disrupted

Various mycotoxins are able to modify the rumen microflora as they exert antimicrobial, anti-protozoal and antifungal activity. In practical terms, this means that mycotoxins that are not degraded by the rumen microflora will escape the rumen and reach the site of absorbtion intact. These mycotoxins will then be absorbed by the organism just as in the case of monogastrics and the animal will be encumbered with a high mycotoxin load

Reduced ruminal motility, on dry matter intake, acid detergent fibre and starch digestion are some other negative impacts reported due to the ingestion of mycotoxin-contaminated feed.

Impact on dairy fertility

ZEN is an oestrogenic metabolite that has been reported to occur in silage (Fig. 1), corn and other grains such as soybeans, wheat, barley, oats, sorghum, sesame seed and hay in many parts of the world.

Chemically, ZEN shows a similar configuration to oestradiol, the female hormone, enabling it to connect to cell receptors.

Thus, ZEN may cause oestrogenic effects as well as abnormal oestrus cycles which ultimately impair fertility.

In a case study, vulvar mucous discharge, repeated AI, increased culling due to infertility and difficult heat detection were also related to the indoor season when animals were fed hay and silage which tested positive for Fusarium sp. contamination.

Besides ZEN, other mycotoxins have been

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shown to cause fertility problems in dairy animals. Westlake et al. (1989) reported that aflatoxins (Afla) were degraded to a low extent (less than 10%) when added to the diet at concentrations from 1-10 g/mL. Metabolisation into aflatoxicol, a highly toxic aflatoxin B1 derivative, was also detected.

Low conception rates, cystic ovaries and uterine infection were observed in dairy animals consuming Afla-contaminated diets.

Deoxynivalenol (DON, also called vomitoxin) has also been associated with reduced feed intake and weight gain and decreased performance. Several field reports and clinical data have associated DON with reduced feed intake in non-lactating dairy cattle and poor performance dairy herds.

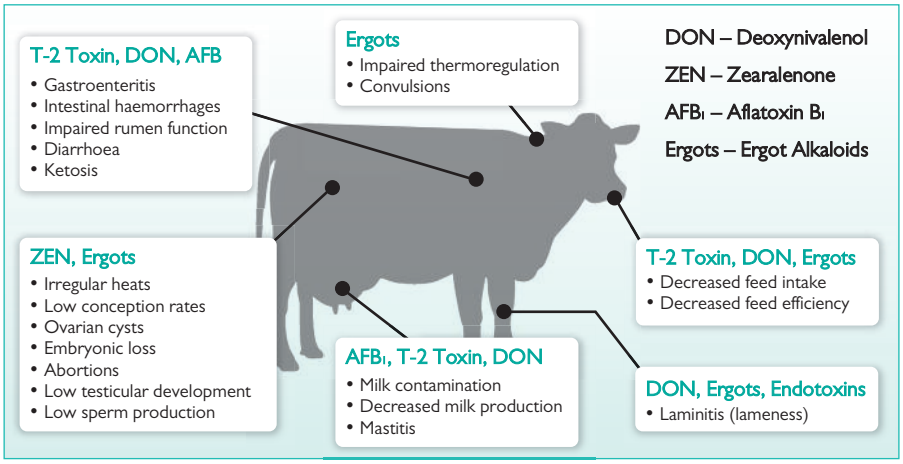

Fig. 2. Most common effects related to the ingestion of feed contaminated with mycotoxins by dairy animals.

In the case of Afla, the most worrying effect is their carry-over into milk as Aflatoxin M1 (AfM1). Afla are considered carcinogenic by the Institute of Applied Research on Cancer (IARC). Although the maximum amount of aflatoxin B1 on dairy feed is well regulated, if the carry-over rates ranging from 1.8- 6.2% as found in the literature are taken into account, the maximum amount of contamination allowed on the dairy ration to meet those requirements would be 1.78ppb, which is well below the 5ppb allowed by the European Commission (EC) Regulation.

Fig. 2 provides an overall picture of the effects of mycotoxins in dairy cattle. The most common and difficult challenges to identify occur when rations contain low levels of mycotoxins and the health effects are subclinical.

The presence of mycotoxins in feed is very often connected with increased incidences of metabolic disorders such as ketosis, retained placenta, displaced abomasum, mastitis, metritis, lameness, elevated somatic cell count and consequently decreased milk production.

Subclinical mycotoxicoses decrease profitability by lowering milk production and quality and finally increasing expenses from inappropriate veterinary therapies.

One management tool

Research has proven that there is no single method for effective mycotoxin control. Most grains and feedstuffs are afflicted by a wide variety of mycotoxin types, and not all varieties of mycotoxins can be destroyed with one deactivation agent.

Combining three modes of action – adsorption, biological degradation of non-adsorbable mycotoxins and protection of the liver and immune system – would provide the most thorough means of deactivating the toxic effects of mycotoxins. ■