Mycotoxin risk evaluator – a new predictive model of risk in dairy production

by Maria Angeles Rodriguez, Technical Service Manager, and Julia Laurain, Technical Service, Olmix.

Mycotoxins are toxic compounds produced by various fungal species that grow on various agricultural commodities. The toxicity of mycotoxins varies, ranging from hepatotoxic or even carcinogenic (aflatoxins) effects, to oestrogenic (zearalenone), immunotoxic (patulin, trichothecenes, fumonisins), nephrotoxic (ochratoxin A) and neurotoxic (tremorgens, ergot alkaloids) effects.

Rumen microbes

For a long time, it was accepted that rumen microbes can detoxify mycotoxins. In some studies with dairy cows, scientists stated that the capacity for mycotoxin detoxification in the dairy cow rumen is lower than believed. Heinz-Kiessling showed that the efficacy of detoxification is not the same for all mycotoxins, DAS, T2, ochratoxin and zearalenone are partially converted, whereas in this study no degradation was noticed for DON and aflatoxin B1. Other studies measured a partial degradation of DON into DOM-1, a less toxic form.

Heinz-Kiessling also showed that the decrease of zearalenone was the result of a reduction to zearalenol, and mainly (90%) to α-zearalenol, which is three to four times more oestrogenic than the parent compound.

Fumonisins are not altered in the rumen. Heinz-Kiessling proved that protozoa are invariably more active than bacteria in the detoxification process, but they are also more sensitive to mycotoxins than bacteria.

In the field, one of the most important effects of mycotoxins (mainly trichothecenes) is an alteration of feed conversion ratio and growth due to lower nutrient absorption (with or without feed intake reduction) and alteration of the rumen flora. The losses in performance, the increased incidence of disease and the reduced reproductive performance are of great economic impact. As a consequence, it is very important to detect and protect animals from mycotoxin contamination in order to avoid this economic loss.

Mycotoxin detection in dairy production is not easy, as one of the characteristics of mycotoxins is their ability to compromise the immune response and consequently, to reduce resistance to infectious diseases. This is now widely considered to be the most important effect of mycotoxins, particularly in developing countries.

This suppression of the immune function, even at levels that do not cause overt clinical mycotoxicosis, provokes symptoms that are common and can be due to other pathologies, so it is likely that farmers and technicians do not think about mycotoxins as a primary cause of the problems that they are facing on the farm.

Predictive model

In order to help them to detect mycotoxin contamination, Olmix developed a predictive model of mycotoxin risk for dairy cows. This article presents the methodology used to build the predictive model and the dairy model is presented as an example.

Mycotoxins can be formed in the field pre-harvest (fusariotoxins: trichothecenes, fumonisins and zearalenones) and/or under poor storage conditions, post-harvest (aflatoxins and ochratoxins mainly).

Depending on field and storage conditions, the occurrence of mycotoxins will be more or less important.

The predictive model developed is based on risk factors for presence of mycotoxins in the diet, which were defined by a literature review and classified into three categories: agricultural practices, storage conditions of the feed and disorders observed on the animals. Each risk factor scored by yes is weighed by a coefficient.

This coefficient is defined by the degree of correlation observed between the risk factor and the level of mycotoxins in the diet as described in the literature. The sum of coefficients for each category is itself weighed and used to calculate the probability of having a significant contamination by mycotoxins in the diet (%) (Table 1).

After bibliography review, the designed predictive model was tested in 18 dairy farms in order to validate its accuracy.

In each farm the predictive model was applied by the farmer and a sample of the diet was taken according to sampling recommendations

for mycotoxin analysis. Each diet sample was analysed by multi-residues method LC MS/MS (COFRAC 1-0632). In order to measure the accuracy of the predictive model, we calculated the correlation between the predictive model scores and the sum of fusariotoxins (trichothecenes, zearalenone and fumonisins) via a calculation of the coefficient of determination (R2).

With a small number of farms, an R2 of 0.70 was obtained, meaning that the correlation coefficient between the model and the chemical analysis is 0.83.

Calculating probability

The objective of the model is not to predict the value of contamination in the diet but to calculate a probability of significant or not occurrence of mycotoxins in the feed. Thus the choice of risk factors and their coefficient seems relevant.

According to the correlation study, this predictive model is a relevant tool in order to identify situations at risk regarding mycotoxin contamination.

This tool is the starting point of mycotoxin diagnosis. Nevertheless, the chemical analysis remains the most efficient tool to confirm mycotoxin contamination and to measure the accurate level of the different

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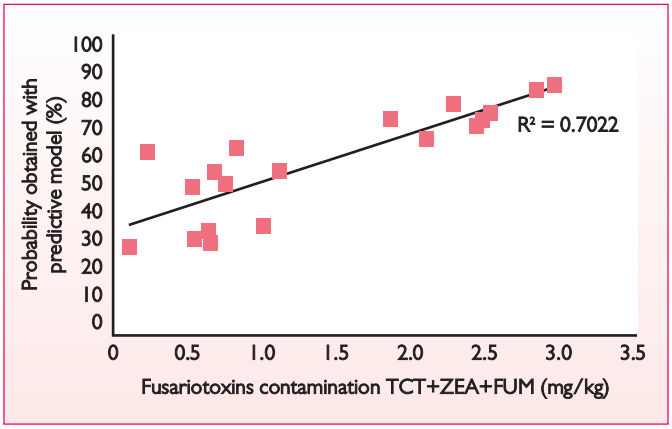
Fig. 1. Correlation between predictive model scores and fusariotoxins contamination of the diet.



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mycotoxins present in the feed. When the score obtained with the predictive model is over 50%, it is strongly recommended to perform a mycotoxin analysis on the complete feed or TMR to confirm the presence of mycotoxins in the feed.

In such case, it is advised to take several small subsamples from the feeder of the animals and to mix them together to have at least 1kg of final sample to send for analysis.

Analytical methods

Most official analytical methods are chromatographic. Alternative strategies such as enzyme linked immunosorbent assay (ELISA) are also largely used as they are easy to implement, cheaper and quicker.

Chromatographic methods are very reliable and can be used on any kind of feed matrices and mix of feed. Matrix effect or matrix interference commonly occurs in ELISA methods resulting in underestimations or overestimations in mycotoxin concentrations in complete feed or TMR samples.

ELISA methods are reliable on single material matrices and not always recommended for complex matrices such as complete feed and TMR.

Whatever the analytical methods used, the sampling procedure remains the most critical point.

Once it is known that mycotoxins are present, and since polycontamination is the common situation, the use of a wide spectrum toxin binder is the most helpful solution to stop or mitigate the problems on the farm. ■

References are available from the author on request

Risk factor	Coefficient
Field	
Corn is produced in a single-crop farming field	++
Corn fields are not ploughed	+++
Fusarium moulds/diseases were observed in the field	+++
Silage was harvested late	+++
Grass silage was cropped after corn	++
Storage	
Moulds are present (red, blue, white or black)	+++
Difficulties in pressing the silage (high DM, speed of harvesting)	++
Silage is warm or took a long time to cool down	+++
Grass silage is not as clean as usual	++
Silage front is consumed too slowly	+
The herd	
Insufficient feed intake	++
Lower milk production than the diet potential	++
Decreasing or unsatisfying body condition	+
Unsatisfying coat condition	+
Low chewing activity	+++
Significant increase in somatic cells or mastitis	+++
Increase of lameness and leg troubles (swollen hooves, joints, dermatitis)	++
Increase of metabolic and pathologic troubles (abomasum displacement, SARA, fatty liver, metritis, jejunal haemorrhage)	+++
Increased turnover (high percentage of heifers)	+
Too soft/liquid faeces	+++
Increase in milk urea	+
Weak calves (diarrhoea, stunted growth, oral and dermal lesions)	+
Fertility troubles (metritis, cysts, placenta retention)	++
Low reproduction performance (heat detection, success at first AI)	+++
The above troubles started with the use of new forages or raw materials	+++

Table 1. Risk factors and applied coefficients.