Mycotoxins in dairy cows: understanding the role of the rumen

Mycotoxins are toxic metabolites, produced by fungi, that can develop in grains and forages. The most well-known and probably the most feared type of mycotoxins in dairy production are aflatoxins, and aflatoxin B1 (AFB1) in particular.

by Margaux Lecolinet, Global Marketing Manager, and Damien Prévéraud, Global Scientific Manager, Mycotoxin Management, Adisseo.
www.adisseo.com

When fed to cows, it is metabolically transformed in the liver into aflatoxin M1 (AFM1), which is hepatotoxic and carcinogenic. AFM1 can be carried over into milk, and this can result in severe public health issues and direct losses for producers.

However, aflatoxins are not the only mycotoxin group of concern. Six other main families of mycotoxins have been identified: ochratoxins, zearalenone, two trichothecene groups (including deoxynivalenol (DON) and T-2 toxin), fumonisins and ergot alkaloids.

Ruminants are naturally partially protected against some mycotoxins, thanks to the ability of the rumen microflora of such animals to produce enzymes that are capable of detoxifying some mycotoxins.

However, most mycotoxins are still a source of major concern regarding the health and performance of cows. The main types of mycotoxins, the sensitivity of dairy cows and their main target organs or systems are presented in Fig. 1.

The severity of symptoms vary as a result of different factors, such as the farm management practices, age, gender, species, nutritional and health status and particularly the nature, concentration and duration of exposure to the mycotoxins. When high doses are fed, acute mycotoxicosis can occur with severe symptoms.

At lower and moderate doses, the symptoms are often sub-clinical and can easily be confused with other disorders. Nevertheless, mycotoxins can already have damageable effects at low doses and for constant exposure, especially on the rumen function, immunity, reproductive performance and lameness.

Some mycotoxins, such as DON and T-2 toxin, are also known to decrease milk production and milk fat when fed long-term. An interesting fact is that rumen microbiota can degrade DON into a less toxic metabolite, and DON can therefore affect the rumen microbiota with a time delay effect and a delayed impact on performance. Rumen health and stability should therefore be at the core of any mycotoxin mitigation strategy for ruminants.

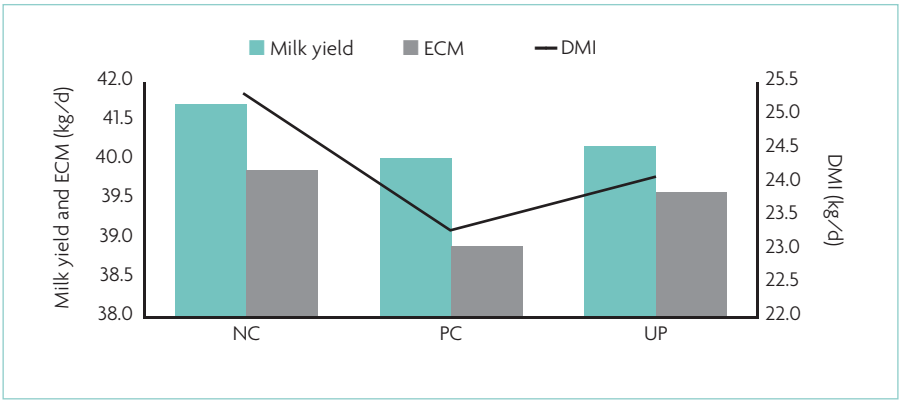


Fig. 2. Effect of mycotoxins and a mycotoxin deactivator on the performance of dairy cows.

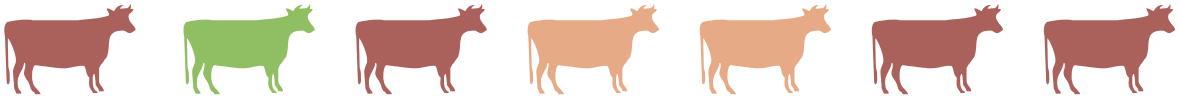
Natural contamination by mycotoxins affects performance and resistance of dairy cows

Dr Nancy Whitehouse, Associate Professor at the University of New Hampshire (USA), has recently conducted an in vivo trial to test the effect of natural mycotoxin contamination on the performance and blood parameters of dairy cows. 24 Holstein cows were used in a replicated randomised block trial for six weeks.

Three treatments were tested: a negative control diet (NC); a positive control diet with naturally high mycotoxin exposure (PC); and a PC diet with the addition of 30g/d of

Continued on page 9

Fig. 1. Sensitivity of dairy cows to different types of mycotoxins.

	Aflatoxin	Ochratoxin	Zearalenone	Deoxynivalenol	T-2 toxin	Fumonisins	Ergot alkaloids
Sensitivity							
Target	Liver damage, immune system, milk contamination		Reproductive system	Rumen function	Rumen function	Digital part of gastrointestinal tract	Central nervous system

	NC	PC	UP	SEM	P value
pH	5.56	5.46	5.54	0.05	
VFA (µM)					
Total VFA	137.7	149.6	134.6	4.15	0.125
Individual					
Acetate (A)	63.8	65.3	64.6	0.87	0.50
Propionate (P)	25.4	24.7	24.4	0.82	0.69
Butyrate	9.2[a]	8.5[b]	9.2[a]	0.17	0.02
Valerate	1.1	1.0	1.1	0.037	0.12
Isobutyrate	0.35[a]	0.31[b]	0.36[a]	0.014	0.02
Isovalerate	0.22[ab]	0.19[b]	0.25[a]	0.012	0.01
A:P ratio	2.6	2.7	2.7	0.14	0.59

Table 1. Rumen parameters of the in vivo trial.

Continued from page 7
a mycotoxin deactivator, that is Unike Plus (UP), from Adisseo.

The NC diet contained 653, 290 and 2,013ppb, while the PC diet contained 1,054, 628 and 4,771ppb of fumonisins, zearalenone and DON, respectively.

Interestingly, production was not affected by the mycotoxins immediately after the beginning of the contamination. Four weeks were needed before any decrease was observed in milk yield or ECM (energy-corrected milk).

Fig. 2 presents the performance of the dairy cows six weeks after the administration of the treatments.

The milk yield, ECM and DMI (dry matter intake) decreased by -8.5, -2.2 and -3.3%, respectively, between the two control groups. The addition of the mycotoxin deactivator successfully mitigated the effects of mycotoxin on these three parameters.

Immune cells were measured in the blood to establish whether there was any effect of this natural contamination on the immune response. The neutrophils, lymphocytes and leukocytes were numerically decreased after six weeks of exposure.

Moreover, the monocytes were statistically decreased, due to mycotoxin contamination. The monocyte number in the blood was 351, 272, 368 cells/ml in the NC, PC and UP diets, respectively. The addition of Unike Plus successfully brought back the monocytes to their correct level.

This is of particular importance for dairy cows as a decrease in monocytes in the blood is a sign of infection in the body. When such a level decreases due to mycotoxins, the cows are restrained from fighting against other infections that could be on-going. The consequences could be, for instance, the re-activation of chronic diseases or mastitis.

A loss of performance can be related to a change in the rumen microbiota

Rumen fluid was collected and the fatty acid parameters were tested to understand the effects of mycotoxins and the mycotoxin deactivator on the rumen of dairy cows. The feeding of Fusarium mycotoxins for six weeks affected the volatile fatty acid (VFA) profile and production.

Butyrate, isobutyrate and isovalerate production were decreased for the PC treatment, compared to the NC treatment, as shown in Table 1.

Butyrate is a lipogenic nutrient and it contributes to the synthesis of long-chain fatty acids in the body and/or milk. Isovalerate is associated with the synthesis of microbial protein and its decrease could be due to a reduction in the cellulolytic bacterial population.

These results show that Fusarium mycotoxins can shift the rumen microbiota and disturb its functioning by disturbing the production of VFAs. However, the decrease in butyrate, isovalerate and isobutyrate was compensated by the addition of Unike Plus to the diet.

To better understand the effect of the mycotoxin deactivator on the rumen function, another in vitro experiment was performed at CERN (Center of Excellence & Research in Nutrition, France).

A two-step approach was applied, both in vivo and in vitro, to evaluate the consequences on the rumen.

Four ruminally fistulated non-lactating Holstein cows were used as rumen fluid donors.

One inoculum, containing 800mg of feed, was considered as the control for each cow, and another inoculum was supplemented with the same diet and 96mg of Unike Plus (UP), but no mycotoxins were added to the feed.

The results of this study are presented in Table 2, and they confirm the ability of the mycotoxin deactivator to modulate the rumen microbiota and therefore the production of VFA.

Both the in vivo and in vitro trials showed the consistent ability of Unike Plus to support an optimal production of VFAs by the rumen microflora.

Furthermore, the trial pursued in CERN showed an increase in propionate and valerate in the UP treatment.

Propionate is of great importance as it is a glucogenic nutrient that has a direct impact on the production of lactose and on the milk yield.

Table 2. Rumen parameters measured in the in vitro trial.

Item (µM)	PC	UP	P value
Total VFAs	92.81	96.31	0.065
Individual			
Acetate	62.55	64.68	0.091
Propionate	18.06	18.85	0.049
Isobutyrate	0.648	0.68	0.0003
Butyrate	11.14	11.64	0.014
Isovalerate	1.09	1.15	<.0001
Valerate	1.05	1.13	<.0001
Total branched VFAs	1.74	1.84	<.0001

Conclusion

It is known that the rumen microbiota of dairy cows contains species that are able to produce enzymes which degrade some mycotoxins.

However, the fact that mycotoxins can also affect the functioning and eubiosis of the rumen needs to be recognised in the animal husbandry field.

Unike Plus has been shown to successfully mitigate the effects of mycotoxins on the performance, immunity and rumen parameters of cows. Part of its mode of action involves naturally enhancing the rumen microbiota and the production of mycotoxin-degrading enzymes. Boosting endogenous bio-inactivation offers an interesting strategy to add to the successful mycotoxin management toolbox. ■